7.0 Description of the Feasibility Study Process and the Remedial Alternatives Developed

7.1 Summary of the Feasibility Study Process

The FS process involved two major phases: the Development and Screening of Alternatives and the Detailed Analysis of Alternatives. Each contaminated environment at RMA (water, structures, and soil) was subdivided into several medium groups of similarly contaminated groundwater plumes, structures, or soil sites to organize and streamline the FS process.

At the outset of the Development and Screening of Alternatives, Remedial Action Objectives (RAOs) were identified. These goals provide general guidance for the FS by identifying the contaminants and media of interest, potential exposure pathways, and preliminary remediation goals. For the On-Post Operable Unit, RAOs were developed for water, structures, and soil based on the results of the IEA/RC, an evaluation of ARARs specified in federal and state environmental laws and regulations, and the provisions of the FFA. (ARARs are listed in Appendix A.) The human health and biota remediation goals are to achieve appropriate remediation such that the selected remedy is protective of both humans and biota.

During the Development and Screening of Alternatives, a wide range of alternatives was evaluated for each medium group with respect to effectiveness, implementability, and cost. Those alternatives retained for further consideration were evaluated during the Detailed Analysis of Alternatives against a set of threshold and primary balancing criteria defined in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (see Section 8). Also taken into account were RMA-specific considerations such as Army safety procedures and USFWS guidance regarding the future use of the site as a national wildlife refuge.

A range of alternatives including no action, institutional controls, containment, and treatment options was developed for each of the water, structures, and soil medium groups. The No Action alternative (as required by EPA) and the No Additional Action alternative were also developed and used as a baseline against which other alternatives were evaluated. The No Action alternative represents current site conditions with no remedial actions undertaken, ongoing, or planned and IRAs discontinued. The No Additional Action alternative involves no action beyond the IRAs currently being implemented on post.

Once the alternatives for each group were evaluated with respect to the seven threshold and primary balancing criteria, the comparative performance of each alternative was evaluated and a range of alternatives was retained for each medium group/subgroup to use in the development of sitewide alternatives. Tables 7.1-1, 7.1-2, and 7.1-3 present descriptions of all individual technologies used to develop the respective sitewide alternatives for the water, structures, and soil medium groups. It should be noted that the No Action and No Additional Action alternatives were developed for each contaminated medium, but were eliminated from consideration during the comparative analysis conducted for sitewide alternatives because they were not sufficiently protective.

All of the alternatives that were identified have several features in common as follows:

- Land-Use Restrictions – The Rocky Mountain Arsenal National Wildlife Refuge Act of 1992 restricts current and future land use, specifies that the U.S. government shall retain ownership of RMA, and prohibits certain activities such as agriculture, use of on-post groundwater as a drinking source, and consumption of fish and game taken at RMA. Continued restriction on land use or access are included as an integral component of all on-post alternatives. Long-term management includes access restrictions to capped and covered areas to ensure the integrity of the containment systems.
- Five-Year Review – In accordance with CERCLA, a review will be performed a minimum of every 5 years after initiation of remedial action to ensure that the various remedial actions where contamination continues to exist, such as the capped areas or the hazardous waste landfill, remain protective of human health and the environment and comply with ARARs.
- Site Monitoring – The Army will continue to conduct air, groundwater, and surface water monitoring programs at RMA, and will continue to fund USFWS to conduct on-post wildlife monitoring programs. Samples will be collected periodically to assess the effectiveness of the remedy for protection of human health and the environment. The actual compliance monitoring program for each of the environmental media will be finalized during the remedial design.
- Revegetation – Any time vegetation is disturbed during remedial construction, the disturbed areas will be revegetated consistent with a USFWS refuge management plan.
- Long-Term Operation and Maintenance – Areas that are remediated will be operated and maintained as required. Management activities may include maintaining capped and covered areas or operating the on-post hazardous waste landfill or groundwater treatment systems.
- On-Post Water Supply – A sufficient on-post water supply will be maintained to support remedial actions (revegetation, habitat enhancement, maintenance of lake levels).

7.1.1 Area of Contamination

An AOC is defined by EPA (OSWER-EPA 1989b) as the areal extent (or boundary) of contiguous contamination. Such contamination must be continuous, but may contain varying types and concentrations of hazardous substances. For on-site disposal, placement occurs when wastes are moved from one AOC into another AOC. Placement does not occur when wastes are left in place or moved within a single AOC.

Placement does not occur when wastes are:

- Treated in situ
- Capped in place
- Consolidated within the AOC
- Processed within the AOC (but not in a separate unit, such as a tank) to improve its structural stability (e.g., for capping or to support heavy machinery

Placement does occur when wastes are:

- Consolidated from different AOCs into a single AOC

- Moved outside of an AOC (e.g., for treatment or storage) and returned to the same or a different AOC
- Excavated from an AOC, placed in a separate unit, such as an incinerator or tank that is within the AOC, and redeposited into the same AOC

If placement does not occur, land disposal restrictions (LDRs) are not applicable to the Superfund action. Correspondingly, if placement on site does occur, LDRs would be applicable to the Superfund action.

At RMA, an AOC was defined that encompasses all principal threat exceedance areas, the majority of human health exceedance areas, and wildlife risk areas defined by the study area that is the subject of the SFS. The boundaries of the AOC are shown on Figure 7.1-1.

7.1.2 Corrective Action Management Unit

Several of the proposed alternatives for the On-Post Operable Unit include the construction and operation of a new on-post hazardous waste landfill for disposal of principal threat and human health exceedance soil and debris as defined in the Detailed Analysis of Alternatives report. Some of this material is RCRA-listed or potentially RCRA-characteristic hazardous waste (based on TCLP). Therefore, during the development of the Detailed Analysis of Alternatives, it was determined that a Corrective Action Management Unit (CAMU) would be required (EPA 1993). The CAMU will incorporate a future hazardous waste landfill, a Basin F Wastepile drying unit, and an appropriate waste staging and/or management area(s). The CAMU was designated by CDPHE under authority of and in accordance with CHWMA. The CAMU designation provides for landfilling of hazardous wastes and movement of waste into the CAMU from anywhere on post, within or outside the AOC, including treatment units. This ROD also provides for use of the CAMU rule as an ARAR for several remedial alternatives (see Appendix A).

The basis for designation of a CAMU and the requirements for the CAMU that are to be specified as part of the designation are provided in 6 CCR 1007-3, Section 264.552. In addition, Section 264.552(a)(3) specifies that where remediation waste placed into a CAMU is hazardous waste, the CAMU shall comply with Part 265, Subparts B, C, D, and E of 6 CCR 1007-3 (Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities [TSDFs]). When such remediation wastes are to remain in place after closure, Section 264.552(a)(3) also requires compliance with the siting requirements for hazardous waste disposal sites (6 CCR 1007-2, Part 2). The new hazardous waste landfill is the only facility within the CAMU to which these siting requirements apply; however, the CAMU may include additional areas as necessary to implement other actions.

A draft CAMU Designation Document (CDD) was submitted to CDPHE on January 12, 1996. It was resubmitted with additional information on March 15, 1996 and was followed by a public comment period. A public hearing was held April 17, 1996, and the comment period closed May 20, 1996. The CDD contains a discussion of the guidelines to be used for the designation of the RMA CAMU as well as a discussion of the operational, monitoring, closure, and post-closure guidelines that will be implemented following designation of the CAMU.

The following decision-making criteria were addressed in designating the CAMU:

- Facilitation of the remedy
- Risks to human health and the environment
- Justification of inclusion of uncontaminated area
- Containment of remediation waste remaining after closure
- Expeditious timing of remedial activity implementation
- Application of treatment technologies
- Minimization of land area where wastes remain in place

CDPHE designated the CAMU by way of the final CDD (Harding Lawson Associates 1996) and a Corrective Action Order. The CAMU boundaries are shown in Figure 7.1-1.

7.1.3 Development of Criteria for Evaluating Soil Contamination

The NCP (EPA 1990a) indicates that acceptable exposure levels for suspected carcinogens are "generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}" and that the 10^{-6} level shall be used as the point of departure for determining remediation goals. EPA (OSWER-EPA 1991b) indicates that action generally is <u>not</u> warranted for sites with additive excess cancer risks less than 10^{-4} and an HI less than 1.0 for noncarcinogenic contaminants. Therefore, the human health SEC for contaminated soil were defined as the additive excess cancer risks of COCs equal to 10^{-4} and/or additive noncarcinogenic HIs equal to 1.0. The boring-by-boring analysis was used to identify the areas of each site, if any, that exceeded the human health SEC and were therefore candidates for remediation. Sites with contaminant concentrations that result in exceedances of these criteria are termed exceedance sites, and their contaminants and resultant volumes are referred to as exceedance COCs and exceedance volumes. Table 7.1-4 presents the human health SEC, which are based on a 10^{-4} cumulative excess cancer risk and noncarcinogenic HI of 1.0 (the criteria ultimately selected in the Detailed Analysis of Alternatives). The human health SEC are based on the lower of the industrial or biological worker PPLVs for each COC. Acute risk criteria were used as human health SEC where they were lower than the corresponding chronic risk human health SEC.

The NCP (EPA 1990a) and EPA guidance documents also develop the concept of a principal threat. Although EPA guidance allows for considerable interpretation in identifying specific sites or areas as principal threats, the EPA fact sheet "Guide to Principal Threat and Low-Level Threat Wastes" (OERR-EPA 1991) provides the following general definition of principal threats:

> ...those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. They include

liquids or other highly mobile materials (e.g., solvents) or materials having high concentrations of toxic compounds. No "threshold level" of toxicity/risk has been established to equate to "principal threat." However, where toxicity and mobility of source material combine to pose a potential [excess] cancer risk of 10^{-3} or greater, generally treatment alternatives should be evaluated.

In addition, the guidance includes a determination as to whether a source material is a principal threat waste:

> . . .should be based on the inherent toxicity as well as a consideration of the physical state of the material (e.g., liquid), the potential mobility of the wastes in the particular environmental setting, and the liability and degradation products of the material. However, this concept of principal threat waste should not necessarily be equated with risks posed by site contaminants via various exposure pathways.

Principal threats, as defined in EPA's "Guide to Selecting Superfund Remedial Actions" (1990b), include the following:

- Areas contaminated with relatively high concentrations of toxic compounds
- Liquids and other highly mobile materials
- Contaminated media (e.g., sediment or soil) that pose a significant risk of excessive exposure
- Media containing contaminants several orders of magnitude above health-based levels

The objective of identifying the principal threat wastes is to focus the remediation on the areas of highest risk to human health and the environment. This focused approach is especially appropriate to RMA because many sites combine large areas of minimal or low-level contamination with small areas of high-level contamination that fall within the definition of principal threats being several orders of magnitude above health-based levels. Because 10^{-4} was set as the human health SEC, the principal threat criteria for RMA soil were established at a 10^{-3} excess cancer risk and a noncarcinogenic HI of 1,000. These criteria are listed by COC in Table 7.1-4. It should be noted and emphasized that the principal threat criteria are risk-management endpoints for use in directing and prioritizing remedial activities; only the SEC denote protective boundaries based on risks (with varying uncertainties) to health. The areas of RMA that exceed the human health SEC and principal threat criteria are shown in Figure 7.1-1.

7.1.4 Soil Volume Modeling and Estimation

Most of the soil alternatives that were evaluated make use of a volume or area estimate to accurately analyze the proposed remedial actions and to develop costs. These volume or area estimates were developed based on the above-described exceedance criteria.

Human health exceedance volume estimates were generated by one of two methods. The distribution of contaminants in some sites was modeled using a commercial software package (TECHBASE). A three-dimensional model, represented by an array of blocks, was created for each site and was bounded vertically by the ground-surface elevation at the time of sampling and depth of the water table (or to a maximum 10-ft depth based on the exposure assessment performed as part of the IEA/RC) and laterally by the site boundary as defined in the Remedial Investigation Summary Report. The modeling routine then searched within a defined volume (based on sample distribution within the site) around each block and used a three-dimensional inverse distance squared algorithm to estimate contaminant concentrations in each block.

Modeled soil concentrations were compared to the human health SEC to identify blocks to be included in the human health exceedance volume for each site. Similarly, soil concentrations were compared to the principal threat criteria to identify blocks to be included in **principal threat exceedance** volume. Concentrations were evaluated to account for potential cumulative effects of multiple contaminants, and all soil located between ground surface and the deepest exceedance block was counted in the exceedance volume. Areas were estimated by projecting all exceedance blocks to the surface and contouring around the surface projection. Perimeters were also estimated from these projections.

Additional volumes and areas were calculated for sites not considered amenable to modeling. In general, if modeling was subject to great uncertainty due to the physical characteristics of a site, highly heterogeneous or uneven spatial contamination, or limited data availability, information from the Study Area Reports (as summarized in the Remedial Investigation Summary Report) was used for volume and area calculations. A boring-by-boring analysis was performed to identify individual sample exceedances, and depth and lateral extents were projected halfway to the next nonexceedance sample. Volumes and areas were calculated using physical dimensions as listed in the Study Area Reports and measured distances between exceedance and nonexceedance samples.

Biota exceedance volumes were developed based on the potential biota risk areas as identified through the risk assessment process described in Section 6.2. The volume was calculated by multiplying the potential risk area by 1 ft (depth). The potential risk area for a site is defined as the entire biota exceedance area within the boundaries of a site, less any human health exceedance area, to avoid double-counting of the volume.

Potential agent and UXO areas were determined from boundaries presented in the Remedial Investigation Summary Report. Potential volume was calculated using these areas and the depths presented in the Detailed Analysis of Alternatives report. The expected agent or UXO volume of soil reflects a 0.1 percent factor to estimate actual agent or UXO occurrence within the potential volume. In addition, UXO surface debris volume was calculated by multiplying the potential UXO area by 1 ft (depth); the result is considered the maximum potential debris volume. For each site, overlap between agent, UXO, or UXO debris volume and human health or biota volume was calculated. Exceedance volumes were adjusted to prevent double-counting of soil volumes. UXO debris volume may include human health and/or biota exceedance volume. Actual human health exceedance volume or biota exceedance volume would increase to the previously unadjusted volume if less than the maximum potential debris volume is encountered.

The volume and area estimates that resulted from these calculations represent the soil quantities used for all soil alternative detailing. Volume increases due to commonly used excavation practices (such as sidesloping, bottom leveling, and perimeter rounding), although expected to be small, were not included in these calculations. Table 7.1-5 lists human health, principal threat, excess biota, agent, UXO, and UXO debris volumes for each soil medium group, and Table 7.1-6 lists the corresponding areas for each soil medium group.

7.2 Remedial Alternatives for Groundwater

7.2.1 Description of Medium

As described in Section 5, contaminated groundwater plumes were detected primarily in the vicinity of the basins, North and South Plants, and the northern and western sections of RMA (Figure 5.4-3). Plumes are generally moving to the north and northwest. Groundwater contaminant plumes predominantly consist of organic compounds (solvents, chloroform, dieldrin, DIMP, DCPD, DBCP, and organosulfur compounds) and fluoride and chloride salts (Tables 5.4-1 through 5.4-5). The overall concentrations and configurations of the plumes suggest that the greatest contaminant releases to the UFS have occurred from Basin A and the Lime Settling Basins, the South Plants chemical sewer, South Plants Tank Farm and production area, the Army and Shell Trenches in Section 36, and the Former Basin F. Plumes emanating from the Motor Pool/Rail Yard and North Plants areas are other sources of contaminant releases to the UFS.

Four groundwater alternatives were developed based on the contaminant concentrations in the individual plumes and evaluated against the remedial alternative screening criteria (see Section 8). A range of alternatives was developed and analyzed for each plume group. These alternatives included no action, continued operation of existing systems, and groundwater extraction and treatment approaches. Alternatives selected for each plume group were combined into four sitewide alternatives that were evaluated and compared against the screening criteria. Groundwater flow modeling utilizing commercially available software (MODFLOW), as summarized in the South Plants/Basin A groundwater flow model report (Foster Wheeler Environmental 1995c), was conducted to assess flow patterns and estimate flow and extraction rates in the South Plants and Basin A areas.

7.2.2 Remedial Action Objectives

The following RAOs were established for on-post groundwater at RMA:

Human Health

- Ensure that the boundary containment and treatment systems protect groundwater quality off post by treating groundwater flowing off RMA to the specific remediation goals identified for each of the boundary systems.
- Develop on-post groundwater extraction/treatment alternatives that establish hydrologic conditions consistent with the preferred soil alternat ives and also provide long-term improvement in the performance of the boundary control systems.

Ecological Protection

- Ensure that biota are not exposed to biota COCs in surface water in concentrations capable of causing acute or chronic toxicity.

7.2.3 Description of Sitewide Remedial Alternatives for Groundwater

Flow of surface water at RMA occurs through a network of streams, lakes, and canals, and flow of groundwater occurs within the alluvium and the uppermost weathered portion of the Denver Formation (UFS). Deeper water-bearing units within the Denver Formation (CFS) are separated from the UFS by low-permeability confining units. Depending on site-specific hydrological characteristics, varying degrees of hydraulic interchange are possible between surface water and groundwater and between the UFS and CFS. In general, analytical and hydraulic data indicate little hydraulic interchange between the UFS and CFS.

The following are considerations for all water alternatives:

- Chloride is expected to attenuate naturally at the NBCS, where it currently exceeds the remediation goal of 250 mg/l. It has been estimated that chloride concentrations will attenuate to concentrations less than the remediation goal at the north boundary within 30 years (MK 1996). Assessment of chloride concentrations will occur during the 5-year site reviews.
- The remediation goal of 540 mg/l for sulfate at the NBCS represents the natural background concentration. It is estimated that sulfate will attenuate to the remediation goal within approximately 25 years (MK 1996). Assessment of sulfate concentrations will occur during the 5-year site reviews.
- NDMA has been detected in the North Boundary Plume Group and at the NBCS. Monitoring for NDMA using a method detection limit of 20 parts per trillion (ppt) is ongoing. If the current monitoring program identifies an NDMA problem, potential design modifications (both on post and at the boundary or adjacent to the boundary) required to achieve the remediation goal at the RMA boundary will be prepared during the remedial design. Any upgrades required for existing treatment systems to address the remediation goal will be incorporated into the remedial actions.

7.2.3.1 Alternative 1 – Boundary Systems

Under Alternative 1, the three **boundary systems** all continue to operate and the systems installed as IRAs are discontinued. The boundary systems are the following:

- Northwest Boundary Containment System (NWBCS)
- North Boundary Containment System (NBCS)
- Irondale Containment System (ICS)

Each of the boundary systems includes groundwater extraction and reinjection systems and a treatment system that removes organic contaminants through carbon adsorption; the NWBCS and NBCS include **slurry walls** for containment and control of groundwater flow. The total amount of water currently treated at the boundary systems is about 1 billion gallons per year. Boundary systems will continue to operate as necessary to achieve remedial action objectives until remediation is complete, and the CERCLA Wastewater Treatment Plant continues to operate as needed to support remedial activities.

Under Alternative 1, the following IRAs are discontinued: the Basin F **extraction system**, the Basin A Neck extraction and treatment system (including breaching of the slurry wall to allow groundwater flow), the Rail Yard extraction system, and the Motor Pool extraction system. Monitoring of boundary system influent and effluent concentrations and groundwater monitoring continue. In addition, caps or covers installed in South Plants and Basin A as part of the soil remedy minimize infiltration of precipitation, thereby reducing contaminant migration through lowering of the water table (**passive dewatering**).

The components of this alternative are summarized in Table 7.2-1. The total estimated cost for this alternative (in 1995 dollars) is $111 million (present worth cost of $80 million). A breakdown of capital and operations and maintenance (O&M) costs is presented in Table 7.2-2. Operations are assumed to continue for at least 30 years.

The operation of each of the boundary systems is detailed below.

Northwest Boundary Containment System

Under Alternative 1, operation of the NWBCS for the Northwest Boundary Plume Group continues. The NWBCS is designed to capture and treat organic contaminants, primarily dieldrin, in groundwater approaching the northwest boundary. The NWBCS includes extraction wells, a slurry wall, reinjection wells, and a GAC adsorption system. When the system was constructed, a slurry wall was installed along the northwest boundary to minimize migration of the contaminated groundwater flowing across that boundary. This wall, constructed of soil/bentonite and originally measuring 1,425 ft long by 3 ft wide by approximately 30 ft deep, was subsequently extended by an additional 665 ft in the northeast direction to intercept groundwater flowing through the alluvial channel to the northeast. The slurry wall extension was keyed a minimum of 10 ft into the existing slurry wall and the extension ranged from 28 to 35 ft deep.

Five extraction wells were also added to the original system, two along the slurry wall, and three southwest of the system. Four reinjection wells were installed to the southeast of the newly installed extraction wells to maintain a separation between contaminants migrating to the north versus contaminants migrating to the northwest and to push groundwater toward the NWBCS along a small, localized groundwater divide. One additional extraction well was added to the southwest extension in early 1996 in response to hydrological changes associated with increased pumping rates in off-post SACWSD water supply wells and decreased infiltration rates at the Havana Ponds (south of Lake Mary and Lake Ladora in Section 11). The southwest extension currently extracts 425 gpm and reinjects approximately 230 gpm; the balance (195 gpm) is reinjected at the original NWBCS system. The rest of the NWBCS extracts and reinjects approximately 600 gpm and 795 gpm, respectively, for a total system flow of approximately 1,025 gpm.

Groundwater is pumped from the extraction wells to the influent sump adjacent to the treatment building. The treatment system consists of three identical GAC vessels, two of which are operated in parallel; the third is used as a backup unit. Each vessel contains 40,000 lbs (1,400 cubic ft) of GAC, is operated in an upflow mode, and has a design capacity of 500 gpm and a residence time of 22 minutes. Treated water is currently discharged into an effluent sump from which the water is pumped (using two 500-gpm pumps) through a recharge header pipe to the reinjection (recharge) wells. The system includes two 500-gpm backup pumps. There are 25 recharge wells that range in depth from approximately 40 ft to 60 ft below the ground surface.

The NWBCS generates two sidestreams requiring treatment or disposal, spent carbon and filter solids. The spent carbon in the adsorbers is removed and regenerated at an off-post facility. The filter solids are drummed and disposed in a landfill regulated by RCRA and CHWMA.

North Boundary Containment System

Under Alternative 1, operation of the NBCS for the North Boundary Plume Group continues, but the operation of the extraction well that is currently part of the Basin F Groundwater IRA is discontinued. The NBCS is a pump-and-treat system that consists of 35 extraction wells approximately 35 ft deep, 12 of which are currently operating, and a soil/bentonite slurry wall 6,740 ft long, 3 ft wide, and 30 ft deep. The extracted water is treated at the treatment plant with GAC and recharged through 15 reinjection trenches. The NBCS was upgraded as part of the IRA for this system. The upgraded system has an improved treatment system, 5 new recharge trenches installed in 1990, and 10 recharge trenches installed in 1988. The trenches parallel the line of extraction wells and are located about 45 ft north of the existing soil/bentonite slurry wall. The existing 38 recharge wells are not in operation, but can be used as backups if needed. The trenches were installed close to the slurry wall to better maintain a reverse gradient.

The NBCS treatment system originally included prefiltration units, three 30,000-lb GAC adsorbers operated in parallel, and a combination of cartridge and bag postfilters. Treated effluent is discharged to a sump for groundwater recharge. The treatment plant has undergone minor operational changes (associated mostly with carbon handling) and now has two 20,000-lb GAC adsorbers operated in series; a third unit is available as a backup. The GAC units operate in downflow mode, and the carbon usage is approximately 100,000 lbs per year. The total capacity of the modified extraction/treatment system is estimated to be 450 gpm. Flow through the treatment plant currently averages 270 gpm.

The NBCS generates two sidestreams requiring treatment or disposal, spent carbon and filter solids. The spent carbon in the adsorbers is removed and regenerated at an off-post facility. The filter solids are drummed and disposed in a landfill regulated by RCRA and CHWMA.

Water levels in the Former Basin F area have been declining for years. The new cap and soil covers in this area will cause the water level to drop further.

Irondale Containment System

Originally, the ICS consisted of two rows of extraction wells and one row of recharge wells. A number of modifications to the ICS system configuration were completed by 1991. The extraction systems have changed as some wells have reached cleanup goals and more contaminated wells have been added to the system. Six of the original extraction wells are currently operating as extraction wells and three of the original extraction wells have been converted to injection wells. Nine new recharge wells, which reduce the water table depression caused by heavy SACWSD pumping rates and which enlarge the zone of captured groundwater on the south edge of the ICS, were installed south of the original system. Additionally, four new extraction wells, three of which are currently operating, were installed 2,000 ft upgradient of the original ICS in an area of greater saturated thickness than the original ICS extraction wells.

Under Alternative 1, all groundwater extracted from the Western Plume Group is treated at the ICS. The water is collected in an influent sump and is treated with GAC adsorption before being reinjected into the aquifer. The treatment plant has three existing treatment trains, each capable of treating a maximum of 700 gpm, although historically only two of the trains have been run simultaneously. The treatment system consists of three identical GAC vessels, two of which are operated in parallel; the third is used as a backup unit. Each vessel contains 40,000 lbs of GAC, is operated in an upflow mode, and has a design capacity of 700 gpm and a corresponding residence time of 15 minutes. Alternative 1 does not include the operation of the two IRA systems (Motor Pool and Rail Yard) that feed into the ICS.

The ICS generates two sidestreams requiring treatment or disposal, spent carbon and filter solids. The spent carbon in the adsorbers is removed and regenerated at an off-post facility. The filter solids are drummed and disposed in a landfill regulated by RCRA and CHWMA.

7.2.3.2 Alternative 2 – Boundary Systems/IRAs

Under Alternative 2, all boundary systems continue to operate as for Alternative 1. Passive dewatering is accomplished through installation of the soil caps and covers. In addition, all the IRAs continue to operate as follows:

- The systems in the Motor Pool and Rail Yard areas continue to extract groundwater and pipe it to the ICS for treatment.
- The Basin F Groundwater IRA continues to extract water north of Basin F for treatment at the Basin A Neck IRA System.
- Under the Basin A Neck IRA, water migrating from Basin A continues to be extracted at Basin A Neck and treated by carbon adsorption. A slurry wall helps control contaminant migration. Water from north of Basin F (Basin F Groundwater IRA) is treated by air stripping and carbon adsorption at Basin A Neck.
- The CERCLA Wastewater Treatment Plant continues to operate as needed to support remedial activities.

Operation of the internal groundwater extraction IRA systems continue as necessary until remedial action objectives are met. The other systems operate as necessary to achieve remedial action objectives until remediation is complete. Groundwater and system influent and effluent monitoring continue under this alternative.

The Rail Yard and Motor Pool IRA systems include seven extraction wells to intercept DBCP contamination and two extraction wells to intercept a TCE plume, respectively. These wells became operational in September 1991. Five of the seven wells in the Rail Yard IRA are currently pumping at a total rate of approximately 230 gpm; the two other wells are backup extraction wells and have not been used. The two wells in the Motor Pool area are currently pumping approximately 100 gpm. The groundwater that is extracted from the Motor Pool Area and Rail Yard extraction wells is pumped from the wells through a metering station to a manifold and then flows via an 8-inch-pipeline to the ICS.

To allow for the additional flow at the ICS, the capacity of this system was increased by bringing the third GAC bed on line, although this option has not been required with present flow rates (the ICS is treating approximately 1,030 gpm as of August 1995). With all three trains operating in parallel, the ICS has a maximum design capacity of 2,100 gpm.

The Basin F Groundwater IRA was implemented to capture contamination moving north out of the Basin F Area. Water is extracted using one well at a rate of 1 to 4 gpm and is then piped to the Basin A Neck IRA system where it is treated prior to reinjection into the Basin A Neck recharge trenches.

The Basin A Neck IRA is a pump-and-treat system that intercepts and treats contamination in groundwater as it moves northwest from Basin A. The extraction system consists of seven alluvial wells that currently pump a total flow of approximately 20 gpm. Three gravel-filled recharge trenches (160 ft, 170 ft, and 180 ft in length) are located across the more permeable, deeper portions of the Basin A Neck. A soil/bentonite slurry wall extends 830 ft across the Basin A Neck between the extraction wells and the recharge trenches to limit recirculation of water between the two systems and inhibit any flow of contaminants not captured by the extraction wells. Treated water from the CERCLA Wastewater Treatment Plant is conveyed to the Basin A Neck treatment plant by an underground pipeline, combined with effluent from the plant at a maximum rate of 5 gpm, and reinjected in the Basin A Neck reinjection trenches. The CERCLA Wastewater Treatment Plant treats water in a semibatch mode on an as-needed basis.

Groundwater extracted from both the Basin A Neck and the Basin F Groundwater IRAs is treated at the Basin A Neck IRA treatment facility. Approximately 1 to 4 gpm of groundwater from the Basin F Groundwater IRA is filtered and then treated in an air stripper. The vapor emissions from the air stripper are treated by two vapor-phase GAC vessels operated in series and an additional backup unit. The effluent from the air stripper is combined with the Basin A Neck IRA influent and treated by pre-filtration through a multimedia filter followed by adsorption in two 2,000-lb carbon vessels in series (one backup vessel is on standby). The GAC effluent is filtered through multimedia filters and discharged to a 3,000-gallon effluent tank. Water from the tank is then filtered through 5-micron bag filters and pumped to the recharge trenches.

The Basin A Neck IRA treatment system generates two sidestreams requiring treatment or disposal, spent carbon and filter solids. The spent carbon in the adsorbers is removed and regenerated at an off-post facility. The filter solids are disposed in a landfill regulated by RCRA and CHWMA.

The components of this alternative are summarized in Table 7.2-1. The total estimated cost for this alternative (in 1995 dollars) is $139 million (present worth cost of $98 million). A breakdown of capital and O&M costs is presented in Table 7.2-2. Operations under this alternative are assumed to continue for at least 30 years.

7.2.3.3 Alternative 3 – Boundary Systems/IRAs/On-Post Dewatering

Alternative 3 includes all components described for Alternative 2. In addition, the water table in the Basin A and South Plants areas is lowered by installing a network of dewatering wells (**active dewatering**) in the central areas of South Plants and Basin A and by installing caps or soil covers in the same area as part of the soil remedy (passive dewatering). Extracted water is treated in a new treatment system by air stripping and GAC adsorption and is then reinjected. Concurrently, groundwater in the South Tank Farm Plume is treated by active **in situ biological treatment**. The South Tank Farm Plume is monitored for the presence of LANPL and, if freely drainable product accumulates to a sufficient thickness, this product is separated and treated. Treatment system and groundwater monitoring is conducted.

Alternative 3 involves removing the most contaminated portions of the Basin A Plume Group, lowering and maintaining future groundwater levels beneath Basin A, and dewatering the South Plants groundwater mound, including the South Plants North Source and South Plants Southeast Plumes. Based on modeling results (see Foster Wheeler Environmental 1995c) for the proposed well layout in Basin A and South Plants, an initial pumping rate of approximately 80 gpm will be used for the first 10 years to reduce the groundwater mound. After 10 years, a pumping rate of 35 gpm will be used to maintain groundwater elevations. Dewatering is accomplished using a system of **horizontal wells** that are installed prior to the initiation of structures medium remedial activities. The caps are installed as part of the soil remedy. The successful operation of the alternative relies on the active extraction/dewatering of the aquifer to reverse horizontal gradients and induce inward flow to the dewatering well system.

The operational goal under Alternative 3 for Basin A is to actively dewater contaminated portions of the soil and the alluvial aquifer. During the first decade (Phase I), the extraction system removes an estimated 60 gpm and the water table is artificially lowered 20 ft or more in the center of Section 36, and to a lesser degree in other areas beneath

Basin A. It is estimated that the long-term pumping rate sufficient to maintain this depressed water level is approximately 20 gpm in Basin A once the soil cap or cover is in place (Phase II). The Basin A Neck IRA intercept system continues to operate and extracts contaminants that are downgradient and beyond the influence of the dewatering system. The dewatering systems are expected to be installed prior to installation of the Basin A and South Plants soil covers, which are to be completed as part of the soil remedy.

Under Alternative 3, dewatering and in situ biotreatment occur concurrently in the South Plants area. Because horizontal wells are used, dewatering under the South Plants Central Processing Area can be initiated before or during demolition or capping activities. The water table is lowered approximately 20 ft through extraction of 20 gpm during the first 10 years (Phase I). The water level is then maintained through extraction of 15 gpm in Phase II. The use of horizontal wells provides flexibility in the overall cleanup of South Plants because the wells can be installed from outside the other construction and demolition areas. The concurrent treatment for the South Tank Farm Plume involves in situ biodegradation of benzene. Water is extracted from the South Tank Farm Plume source area at a rate of 10 gpm. The extracted groundwater is transferred to a collection tank and then reinjected after the appropriate amounts of hydrogen peroxide and nutrients have been added; reinjecting the water flushes the plume as it enhances biological growth and degradation of contaminants in the subsurface. When the northernmost cell (Cell I) of the in situ biotreatment system becomes inefficient after several years due to dewatering of the South Plants area, three of the injection wells in Cell I are converted to extraction wells and become part of the overall dewatering system. The remainder of the in situ system continues to operate for an estimated 10 years.

Each of the proposed extraction systems under Alternative 3 requires installation of performance monitoring wells. Groundwater-quality and water-level data from the newly installed performance monitoring wells are used to evaluate the effectiveness and operation of the extraction/dewatering system. The final location of the wells is based upon review of existing well locations and screened intervals. Where appropriate, existing wells are utilized in place of construction of new monitoring wells.

The components of this alternative are summarized in Table 7.2-1. The total estimated cost for this alternative (in 1995 dollars) is $179 million (present worth cost of $130 million). A breakdown of capital and O&M costs is presented in Table 7.2-2. Operations under this alternative are assumed to continue for at least 30 years.

7.2.3.4 Alternative 4 – Boundary Systems/IRAs/Intercept Systems

Alternative 4 includes all components of Alternative 2 as well as groundwater extraction from the Section 36 Bedrock Ridge Plume in an interceptor configuration followed by treatment at the existing Basin A Neck IRA (which includes air stripping and GAC adsorption). Treated water is reinjected to the aquifer through the existing recharge trenches. The interceptor configuration is designed to prevent further migration of the Section 36 Bedrock Ridge Plume northeast out of the Basin A area towards the First Creek drainage. Alternative 4 is accomplished in conjunction with the soil remedy, which includes caps or soil covers over the Basin A and South Plants areas, and caps and slurry walls associated with the Shell Trenches and the Army Complex Trenches.

Groundwater-quality and water-level data are collected and used to evaluate the effectiveness and operation of the Bedrock Ridge and Basin A Neck systems. It is assumed that there are sufficient existing wells in both areas to be used for performance monitoring, so no new wells are installed. Wells closed during the implementation of the soil remedy will be replaced if required to maintain adequate performance monitoring. Further evaluation of the hydraulic control provided by the entire system (wells, caps, and slurry walls) will be performed during the remedial design.

Alternative 4 also includes groundwater monitoring of the CFS. Monitoring of the CFS is to be conducted in the South Plants area, the Basin A area, and close to Basin F. Data from these wells are assessed to determine whether contaminant levels within the CFS are increasing or migrating significantly with time. Due to poor construction or documentation of well-installation techniques, screened intervals, and bentonite-seal locations, approximately 30 to 40 CFS wells are closed and abandoned. Both groundwater and system monitoring continues.

Water levels in Lake Ladora, Lake Mary, and Lower Derby Lake will be maintained to support aquatic ecosystems. The biological health of the ecosystems will continue to be monitored. Lake-level maintenance or other means of hydraulic containment or plume control will be used to prevent South Plants plumes from migrating into the lakes at concentrations exceeding CBSGs in groundwater at the point of discharge. Groundwater monitoring will be used to demonstrate compliance.

The components of this alternative are summarized in Table 7.2-1. The total estimated cost for this alternative is $146 million (present worth cost of $104 million). A breakdown of capital and O&M costs is presented in Table 7.2-2. Operations under this alternative are assumed to continue for at least 30 years.

7.3 Description of Sitewide Remedial Alternatives for Structures

7.3.1 Description of Medium

As described in Section 5 and detailed in the structures inventory tables (Tables 5.4-6 through 5.4-9), approximately 94 percent of the remaining 798 structures at RMA were identified as potentially contaminated based on previous use or location in manufacturing areas. To date, 525 structures at RMA have been demolished. The debris has been disposed off post or is awaiting disposal.

7.3.2 Remedial Action Objectives

The RAOs for structures were developed based on potential risks, both physical and chemical, to human and ecological receptors through the potential exposure pathways of inhalation, dermal contact, or ingestion of contaminants potentially present in, or emanating from, structures at RMA. They were also based on the potential for the movement of contaminants through soil, air, or water from structures. The RAOs for the structures medium are as follows:

Human Health

- Prevent contact with the physical hazards and contaminant exposure associated with structures.
- Limit inhalation of asbestos fibers to applicable regulatory standards.
- Limit releases or migration of COCs from structures to soil or water in excess of remediation goals for those media or to air in excess of risk-based criteria for inhalation as developed in the HHRC.

Ecological Protection

- Prevent contact with the physical hazards associated with structures.
- Prevent biota from entering structures that are potentially contaminated.

7.3.3 Description of Sitewide Remedial Alternatives for Structures

Before any structures remedial alternatives can be implemented, each structure must be visually examined to determine the structural integrity of the building. The decontamination status of each structure is also determined with respect to ACM and PCBs.

The scope of the ongoing Asbestos IRA is to remove and dispose all ACM from RMA structures, piping, and tanks. The Asbestos IRA continues as part of the structures remediation, so any asbestos remaining in the structures will be removed as an integral part of the remediation process and disposed in the on-post hazardous waste landfill.

Agent-related and nonagent-related process equipment and piping located in the North Plants and South Plants is being sampled, decontaminated, and dismantled under the Chemical Process-Related Activities IRA. Although much of the equipment in these areas has already been removed, process-related equipment not remediated as part of this IRA will be disposed in the new on-post TSCA-compliant hazardous waste landfill as part of the final remedy.

Army structures have been subject to a comprehensive sampling program under the PCB IRA to identify all PCB-contaminated equipment and structural materials. The results of this program are to be presented in the PCB IRA completion report. PCB-contaminated materials will be disposed in the on-post hazardous waste landfill, which will meet Toxic Substances Control Act (TSCA) requirements. The results of the PCB IRA completion report for Army structures will be incorporated into remediation activities as discussed below.

Equipment and structures for which the Army has responsibility will be handled as follows:

- Equipment – PCB fluids will be drained and sent off post for disposal in compliance with applicable TSCA regulations. PCB-contaminated equipment will be disposed in the new on-post hazardous waste landfill that meets TSCA requirements. The equipment will be disposed under one of three possible scenarios:
  - Identified and disposed as part of the ongoing PCB IRA.
  - Identified under the PCB IRA but disposed under the final structures cleanup.
  - Agent-decontaminated materials to be disposed under the final structures cleanup.
- Structures – The PCB contamination in No Future Use structural materials will be identified in the PCB IRA completion report. Based on a 50 parts per million (ppm) action level, structural materials will be addressed in one of two ways:
  - Structural materials with PCB concentrations of 50 ppm or above that exist above the ground elevation, as well as contaminated parts of ground floor slabs and foundations that will be removed, will be identified prior to demolition, segregated during demolition, and disposed in the on-post TSCA-compliant hazardous waste landfill. Similar materials with PCB concentrations less than 50 ppm will be disposed according to use history as described in the alternative detailing.
  - PCB-contaminated sections of ground floor slabs or foundations at or below grade that are not required to be demolished as part of the remediation and with PCB concentrations of less than 50 ppm will be left in place. However, slabs or foundation materials with PCB concentrations of 50 ppm or greater will be removed during demolition and disposed in the new TSCA-compliant hazardous waste landfill.

Army Future Use structures have been managed for occupancy under current environmental and worker protection regulations. There is no evidence of PCB contamination in this medium group.

Potential PCB contamination in Shell structures are to be identified through visual evidence, and will be disposed in accordance with TSCA requirements and guidance. Structures and equipment for which Shell has responsibility are so indicated in Tables 5.4-6 through 5.4-9 and will be handled as follows:

- All Shell buildings to be demolished during the final remedy will be inspected for equipment containing fluids potentially contaminated with PCBs prior to demolition. Potentially contaminated fluids will be drained and sent off post for disposal in compliance with applicable TSCA regulations. Equipment that contained these fluids, as well as all other equipment, will be disposed in the on-post TSCA-compliant hazardous waste landfill. Significant Contamination History structures will be demolished and the resulting debris will be placed in the new on-post TSCA-compliant hazardous waste landfill. Other Contamination History structures will be evaluated by Shell and EPA for any visual evidence of leaks or spills. If observed in areas where potential PCB releases may be reasonably expected to occur, the affected debris will be disposed in the on-post TSCA-compliant hazardous waste landfill. Examples of this type of visual evidence would include stains near equipment potentially containing PCB fluids or stains in buildings where there are numerous instances of equipment potentially containing PCB-contaminated fluids. Further details of this work will be addressed at the remedial design stage.
- All fluorescent-light ballasts will be disposed at an off post-disposal facility in accordance with applicable TSCA regulations.

Shell does not have responsibility for any structures within the Future Use or Agent History Groups.

Most of the demolition at RMA will consist of dismantling (i.e., reducing a standing building to a pile of debris), using a combination of demolition techniques and equipment such as a backhoe with a thumb attachment, a wrecking ball and crane, or a crane and clamshell, or by performing piece-by-piece disassembly, sawing, or crushing. Additional techniques, such as structural undermining or explosives demolition, may be appropriate in some cases. Standard dust-suppression measures consistent with the remediation goals are used throughout the demolition process to meet state and federal requirements.

As the structural debris is removed, materials are segregated for purposes of recycling and waste classification. Economically recyclable materials, such as scrap metals, are collected for salvage. Structural materials not salvaged are placed in a bermed dirt or concrete staging area. The debris is segregated into potentially hazardous and nonhazardous waste as the structure is dismantled and placed in separate containment areas. The debris is sized for disposal concurrent with stockpiling to limit the amount of settling in the landfill or consolidation area. Due to the potential hazards, these handling activities are limited for Agent History structures.

The debris is then transported by truck to the disposal site. Debris from Agent History structures is monitored for the presence of agent and treated, as necessary, before disposal in the hazardous waste landfill. Agent-contaminated structures will be handled in compliance with AR 385-61, AR 50-6, and Department of Defense regulations in effect at the time of remediation. Action must be taken to treat the agent contamination within the structure or debris to a level consistent with Army regulations (3X or 5X) so it may be properly disposed. Debris from the Significant Contamination and Other Contamination History structures are taken directly to the hazardous waste landfill, depending on the remedial alternative. Floor slabs and foundations at or below grade for the Other Contamination History and Significant Contamination History Groups are left in place unless they must be removed to provide access to underlying contaminated soil (i.e., the slabs and foundations of structures located in the South Plants Central Processing Area within principal threat or human health soil exceedance areas, which are removed to a depth of 5 ft along with the contaminated soil). Floor slabs not removed are broken in place to prevent water ponding and are contained beneath the soil covers specified for the specific areas in which they occur (see Section 7.4).

7.3.3.1 Alternative 1 – Landfill/Cap in Place

Alternative 1 addresses each of the three No Future Use medium groups as follows:

- No Future Use, Significant Contamination History – The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris disposed in the on-post hazardous waste landfill.
- No Future Use, Other Contamination History – The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris consolidated and capped in one of three places: the Rail Yard, North Plants, or the South Plants Central Processing Area. Multilayer caps are used for containment of the debris.

- No Future Use, Agent History – The structures are dismantled using dust controls and air monitoring, the debris monitored for the presence of Army chemical agent and caustic washed as necessary, and the resulting debris disposed in the on-post hazardous waste landfill. Spent caustic wash is treated in an evaporator/crystallizer; the resulting waste salts are drummed and disposed in the on-post hazardous waste landfill.

The components of this alternative are summarized in Table 7.3-1. The total estimated cost of this alternative (in 1995 dollars) is $114 million (present worth cost of $106 million). A breakdown of capital and O&M costs for each component of this alternative is presented in Table 7.3-2. This alternative requires approximately 2 years for implementation.

7.3.3.2 Alternative 2 – Landfill/Consolidate

Alternative 2 addresses each of the three No Future Use medium groups as follows:

- No Future Use, Significant Contamination History – The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris disposed in the on-post hazardous waste landfill.
- No Future Use, Other Contamination History – The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris transported to the Basin A consolidation area for use as gradefill.
- No Future Use, Agent History – The structures are dismantled using dust controls and air monitoring, the debris monitored for the presence of Army chemical agent and caustic washed as necessary, and the resulting debris disposed in the on-post hazardous waste landfill. Spent caustic wash is treated in an evaporator/crystallizer; the resulting waste salts are drummed and disposed in the on-post hazardous waste landfill.

The components of this alternative are summarized in Table 7.3-1. The total estimated cost of this alternative (in 1995 dollars) is $112 million (present worth cost of $104 million). A breakdown of capital and O&M costs for each component of this alternative is presented in Table 7.3-2. This alternative requires approximately 2 years for implementation.

7.3.3.3 Alternative 3 – Landfill

Alternative 3 addresses each of the three No Future Use medium groups as follows:

- No Future Use, Significant Contamination History – The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris disposed in the on-post hazardous waste landfill.
- No Future Use, Other Contamination History – The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris disposed in the on-post hazardous waste landfill.
- No Future Use, Agent History – The structures are dismantled using dust controls and air monitoring, the debris monitored for the presence of Army chemical agent and caustic washed as necessary, and the resulting debris disposed in the on-post hazardous waste landfill. Spent caustic wash is treated in an evaporator/crystallizer; the resulting waste salts are drummed and disposed in the on-post hazardous waste landfill.

The components of this alternative are summarized in Table 7.3-1. The total estimated cost of this alternative (in 1995 dollars) is $118 million (present worth cost of $109 million). A breakdown of capital and operating and maintenance costs for each component of this alternative is presented in Table 7.3-2. This alternative requires approximately 2 years for implementation.

7.4 Description of Sitewide Remedial Alternatives for Soil

7.4.1 Description of Medium

As described in Section 5, the majority of contamination is present in the trenches, disposal basins, and the South Plants manufacturing area, covering approximately half of the central six sections of RMA (Figure 5.4-1 and Tables 5.4-11 and 5.4-12). The highest contaminant concentrations tend to occur in soil within 5 ft of the ground surface, although exceptions are noted, particularly at sites where burial trenches, disposal basins, or manufacturing complexes are located. In general, contaminant distribution is significantly influenced most by the physical and chemical properties of the contaminants, the environmental media through which they are transported, and the characteristics of the sources (i.e., former manufacturing and disposal practices).

7.4.2 Remedial Action Objectives

The RAOs identified for the soil medium are the following:

Human Health

- Prevent ingestion of, inhalation of, or dermal contact with soil or sediments containing COCs at concentrations that generate risks in excess of 1×10^{-4} (carcinogenic) or an HI greater than 1.0 (noncarcinogenic) based on the lowest calculated reasonable maximum exposure (5th percentile) PPLV values (which generally represent the on-site biological worker population).
- Prevent inhalation of COC vapors emanating from soil or sediments in excess of acceptable levels, as established in the HHRC.
- Prevent migration of COCs from soil or sediment that may result in off-post groundwater, surface water, or windblown particulate contamination in excess of off-post remediation goals.
- Prevent contact with physical hazards such as UXO.
- Prevent ingestion of, inhalation of, or dermal contact with acute chemical agent hazards.

Ecological Protection

- Ensure that biota are not exposed to COCs in surface water, due to migration from soil or sediment, at concentrations capable of causing acute or chronic toxicity via direct exposure or bioaccumulation.
- Ensure that biota are not exposed to COCs in soil and sediments at toxic concentrations via direct exposure or bioaccumulation.

7.4.3 Description of Sitewide Remedial Alternatives for Soil

The implementation of any soil alternative is tied to structures remediation because most of the structures at RMA are located in areas of soil contamination. In such areas, structures must be demolished before components of the soil remedy, such as excavation or the construction of containment systems, can be implemented.

PCB-contaminated soil at RMA was identified under the PCB IRA program. The remedial activities for PCB-contaminated soil are dependent on the concentration and location as follows:

- The three PCB-contaminated soil areas identified by the PCB IRA with concentrations of 250 ppm or greater will be removed. The limits of contamination will be determined based on visual evidence with immunoassay field confirmation sampling (SW-846).
- There are five PCB-contaminated soil areas identified by the PCB IRA with concentrations from 50 ppm to below 250 ppm. These areas will receive a minimum of 3 ft of soil cover, and the PCB-contaminated soil there will be left in place. The soil cover will be maintained as part of the wildlife refuge and is subject to the institutional controls of the FFA.
- No remaining areas of PCB-contaminated soil with concentrations above 50 ppm have been identified by the PCB IRA. If necessary, any suspected PCB soil contamination areas will be characterized further during the remedial design. If additional PCB-contaminated soil is found in concentrations of 50 ppm or above, the Army will determine any necessary remedial action in consultation with EPA.
- PCB-contaminated soil that is excavated under any soil alternative is disposed in the on-post TSCA-compliant landfill.

7.4.3.1 Alternative 1 – Caps/Covers

Alternative 1 involves the containment of 1 ,200 acres through the installation of a cap and the landfilling of 290,000 bank cubic yards (BCY) of contaminated soil. Under this alternative, multilayer caps are installed to contain contaminated soil. The capped areas are located in the central portions of RMA (Figure 7.4-1). The existing cover for the Former Basin F Subgroup is augmented to improve performance and meet EPA guidance governing caps and covers. A composite cap is constructed over the existing cover for the Basin F Wastepile. Approximately 17.8 million BCY of borrow materials are required as backfill and gradefill to achieve the design grades for capping, and an additional 11.3 million BCY of borrow (clay and common fill) are required for construction of the caps.

In addition to capping, all sewer manholes are plugged with cement. Slurry walls are used in conjunction with caps for the Complex Trenches, Shell Trenches, Hex Pit, and Buried M-1 Pits Subgroups to augment the containment of these sites. The groundwater inside the contained area is pumped and treated if necessary.

Areas outside the central portions of RMA that are suspected to have potential chemical agent or UXO presence are screened and cleared. Any excavated agent-contaminated soil identified during agent monitoring is treated by caustic washing and then landfilled. In addition, any identified HE-filled (high explosive) or agent-filled UXO is excavated, packaged, and transported off post to an existing Army facility for detonation and disposal (unless the UXO is unstable and must be detonated on post) or other demilitarization process. The 200,000 BCY of contaminated soil and debris from several sites in the eastern and western portions of RMA are excavated and placed in the on-post hazardous waste landfill along with debris from munitions screening operations. The

110,000 BCY of human health exceedances from the Surficial Soil, Lake Sediments, and Agent Storage Medium Groups are also landfilled.

Soil posing risk to biota is generally capped as discussed above. No action is undertaken for soil that potentially poses risks to biota that is located outside of the capped area including Upper Derby Lake and the Surficial Soil, Ditches/Drainage Areas, and Agent Storage Medium Groups. The soil in these areas is sampled periodically. No action (other than monitoring) is conducted for the aquatic lake sediments. Ongoing monitoring of biota in these areas will be conducted in support of design refinement/design characterization.

The components of this alternative are summarized in Table 7.4-1. The total estimated cost for this alternative (in 1995 dollars) is $542 million (present worth cost of $386 million). A breakdown of capital and O&M costs for each component of this alternative is presented in Table 7.4-2. This alternative requires approximately 17 years for implementation.

7.4.3.2 Alternative 2 – Landfill/Caps

Alternative 2 involves containment of approximately 490 acres through the installation of multilayer caps and the landfilling of 2 million BCY of contaminated soil. The areas outside the central portion of RMA are excavated and landfilled. The 110,000 BCY of human health exceedances from the Lake Sediments, Surficial Soil, and Agent Storage Medium Groups are landfilled. Any excavated agent-contaminated soil identified during monitoring is treated by caustic washing and then landfilled. In addition, any HE-filled or agent-filled UXO identified through geophysical surveys or other screening methods are excavated, packaged, and transported off-post to an existing Army facility for detonation and disposal (unless the UXO is unstable and must be detonated on post) or other demilitarization process. Chemical sewer lines in the central portion of the South Plants complex and within the Complex Trenches are plugged with cement and the sanitary sewer manholes are plugged. The remaining chemical sewers and associated contaminated soil are excavated and placed in the on-post hazardous waste landfill.

A 390-acre area in the central portion of RMA is covered with multilayer caps. The capped areas consist of human health exceedance areas and areas with residual contamination in Section 36, the South Plants Central Processing Area, and the Former Basin F (Figure 7.4-2). The existing cover for the Former Basin F Subgroup is augmented to improve performance and meet EPA guidance governing caps and covers. A composite cap is constructed over the existing cover for the Basin F Wastepile. Approximately 8.8 million BCY of borrow materials are required as backfill and gradefill to achieve the design grades for capping, and an additional 3.9 million BCY of borrow (clay and common fill) are required for construction of the caps.

Slurry walls are used in conjunction with caps for the Complex Trenches, Shell Trenches, Hex Pit, and Buried M-1 Pits Subgroups to augment the containment of these sites. The groundwater inside the contained area is pumped and treated if necessary to maintain lowered water table elevations.

Soil posing risk to biota within the central six sections of RMA is generally excavated and landfilled as discussed above. No action is undertaken for soil that potentially poses risks to biota that is located outside of the capped area including Upper Derby Lake and the Surficial Soil, Ditches/Drainage Areas, and Agent Storage Medium Groups. Although a residual risk to biota exists outside the capped area, the magnitude of the residual risk is comparatively low (see Section 6.2.4.3) and the short-term destruction of habitat is minimized. The soil in these areas is sampled periodically. No additional action other than monitoring is conducted for the aquatic lake sediments. Ongoing monitoring of biota in these areas will be conducted in support of design refinement/design characterization.

The components of this alternative are summarized in Table 7.4-1. The total estimated cost for this alternative (in 1995 dollars) is $383 million (present worth cost of $276 million). A breakdown of capital and O&M costs for each component of this alternative is presented in Table 7.4-2. This alternative requires approximately 16 years for implementation.

7.4.3.3 Alternative 3 – Landfill

Alternative 3 involves the containment of 3.4 million BCY of contaminated soil in an on-post hazardous waste landfill. Approximately 100 acres of principal threat or human health exceedance soil areas are contained with a multilayer cap instead of being landfilled, and 300 acres are capped (multilayer cap), after removing the human health exceedance volume and landfilling, to address residual contamination (Figure 7.4-3).

Contaminated soil from nearly all of the sites (3.4 million BCY total) is excavated and landfilled. Chemical sewers and associated contaminated soil are excavated and placed in the on-post hazardous waste landfill. The 87,000 BCY of human health exceedance volume from the Surficial Soil Medium Group, soil with human health exceedances in the Agent Storage Medium Group (2,900 BCY), and human health exceedances and soil that may pose a risk to biota from the Lake Sediments (including portions of Upper Derby Lake) and Ditches/Drainage Areas Medium Groups (90,000 BCY) are also excavated and landfilled. Any excavated agent-contaminated soil identified during monitoring is treated by caustic washing and then landfilled. The excavation of the Former Basin F, Buried M-1 Pits, Shell Trenches, and Hex Pit Subgroups requires the use of **vapor- and odor-suppression measures** such as foam, liners, or a transportable structure.

The sanitary sewer manholes are plugged. Any HE-filled (high explosive) and agent-filled UXO identified through geophysical surveys or other screening methods are excavated, packaged, and transported off post to an existing

Army facility for detonation and disposal (unless the UXO is unstable and must be detonated on post) or other demilitarization process.

The Basin F Wastepile and the Complex Trenches Subgroups are left in place and capped. A composite cap is constructed over the existing cover for the Basin F Wastepile. Following the excavation and landfilling of human health exceedances, 390 acres in Section 36, South Plants Central Processing Area, and the Former Basin F are capped (multilayer caps). Approximately 10.1 million BCY of borrow materials are required as backfill and gradefill to achieve the design grades for capping, and an additional 3.86 million BCY of borrow are required for construction of the cap.

Slurry walls are used in conjunction with the caps for the Complex Trenches Subgroup to augment the containment of this site. The groundwater inside the contained area is pumped and treated.

Soil posing risk to biota within the central six sections of RMA is generally excavated and landfilled as discussed above. No action is undertaken for soil that potentially poses risks to biota in the Surficial Soil Medium Group, but the soil in this area is sampled periodically. Although a residual risk to biota exists in this medium group, the magnitude of the residual risk is comparatively low (see Section 6.2.4.3) and the short-term destruction of habitat is minimized. No action other than monitoring is conducted for the aquatic lake sediments. Ongoing monitoring of the biota in these areas will be conducted in support of design refinement/design characterization.

The components of this alternative are summarized in Table 7.4-1. The total estimated cost for this alternative (in 1995 dollars) is $576 million (present worth cost of $384 million). A breakdown of capital and O&M costs for each component of this alternative is presented in Table 7.4-2. This alternative requires approximately 22 years for implementation.

7.4.3.4 Alternative 4 – Consolidation/Caps/Treatment/Landfill

Alternative 4 involves **consolidation** of 1.5 million BCY of soil with low levels of contamination into Basin A, Former Basin F, and the South Plants Central Processing Area; capping or covering of 1,100 acres of contaminated soil; landfilling of 1.7 million BCY of soil and debris; and treatment of 207,000 BCY of soil by solidification/ stabilization (Figure 7.4-4). This alternative also includes a contingent soil volume of 150,000 BCY that may be landfilled. The locations of the contingent volume will be based on visual field observations such as soil stains, presence of barrels, or newly discovered evidence of contamination. In addition, 14 samples from North Plants, Toxic Storage Yards, Lake Sediments, Sand Creek Lateral, and Burial Trenches Medium Groups and up to 1,000 additional confirmatory samples may be used to identify the contingent soil volume requiring landfilling.

Approximately 180,000 BCY of principal threat soil in the Former Basin F are treated by in situ solidification/stabilization, and 26,000 BCY of principal threat and human health exceedance soil from the Buried M-1 Pits are excavated, solidified, and placed in the on-post landfill. Excavation of the Buried M-1 Pits will be conducted using vapor- and odor-suppression measures.

Approximately 1,000 BCY of principal threat material from the Hex Pit are treated using an innovative thermal technology. The remaining 2,300 BCY are excavated and disposed in the on-post hazardous waste landfill. Remediation activities will be conducted using vapor- and odor-suppression measures as required. Treatability testing will be performed during remedial design to verify the effectiveness of the innovative thermal process and establish operating parameters for the design of the full-scale operation. The innovative thermal technology must meet the treatability study technology evaluation criteria as described in the dispute resolution agreement (PMRMA 1996). Treatment will be revised to a solidification/stabilization technology if all evaluation criteria for the innovative thermal technology are not met. Treatability testing for solidification will be performed to verify the effectiveness of the solidification process and determine appropriate solidification/stabilization agents. Treatability testing and technology evaluation will be conducted in accordance with EPA guidance (OSWER-EPA 1989a) and EPA's "Guide for Conducting Treatability Studies Under CERCLA" (1992).

The approximately 650,000 BCY of highly contaminated soil from the Basin F Wastepile and the Section 36 Lime Basins Subgroups is excavated (using vapor- and odor-suppression measures) and disposed in triple-lined cells within the on-post hazardous waste landfill. Soil from the Basin F Wastepile not passing the **EPA paint filter test** (SW-846, Method 9095) will be reduced to acceptable moisture-content levels by using a dryer in an enclosed structure. Any contaminants released from the soil during drying will be captured and treated.

Approximately 1 million BCY of human health exceedance soil from other sites throughout RMA, as well as debris from UXO clearance operations, are landfilled under this alternative. Any excavated agent-contaminated soil identified during monitoring is treated by caustic washing and then landfilled. In addition, any identified HE-filled and agent-filled UXO are excavated, packaged, and transported off post to an existing Army facility for detonation and disposal (unless the UXO is unstable and must be detonated on post) or other demilitarization process.

Slurry walls are used in conjunction with the caps for the Shell Trenches and Complex Trenches Subgroups to augment the containment of these sites. For the purposes of conceptual design and costing during the FS, it was assumed that the groundwater inside the contained area is pumped and treated at the Basin A Neck treatment system (this assumption will be reevaluated during the remedial design). The Shell Trenches and Complex Trenches caps are designed to be **RCRA-equivalent caps**. The complex trenches cap includes a 6-inch-thick formed concrete layer. The sanitary sewer manholes and the chemical sewers located in the South Plants Central Processing Area and Complex Trenches are plugged. The remaining human health exceedance soil and chemical sewer debris are excavated and placed in the landfill.

Soil posing a potential risk to biota within the Secondary Basins as well as the North Plants Manufacturing Area is contained in place using 2-ft-thick soil covers. Soil posing a potential risk to biota within the Ditches/Drainage Areas, Sanitary Landfills, Section 36 Balance of Areas, Sand Creek Lateral, South Plants, and some of the Lake Sediments and Surficial Soil Medium Groups/Subgroups are consolidated as gradefill soil within Basin A, South Plants Central Processing Area, or Former Basin F and are contained beneath the cap or soil covers for those sites. The construction of the cap and covers of these three areas requires approximately 5.7 million BCY of gradefill to provide sufficient slope for proper drainage. Other sites require an additional 3.1 million BCY of backfill and gradefill to achieve design grades for caps/covers. An additional 5.1 million BCY of borrow material are required for construction of all caps/covers. The Former Basin F cap is designed to be RCRA-equivalent. Basin A and the South Plants Central Processing Area are contained with a 4-ft-thick soil cover and, respectively, a 6-inch-thick formed concrete layer and 1-ft-thick crushed concrete layer for prevention of biota intrusion.

The South Plants Balance of Areas is covered with a variable-thickness soil cover. The former human health exceedance area is covered with a 3-ft-thick soil cover and the former potential risk to biota area is covered with a 1-ft-thick soil cover. Prior to placing this cover, two composite samples per acre will be collected to ensure that the soil under the 1-ft-thick soil cover does not exceed human health or principal threat criteria. If the residual soil is found to exceed these levels, the 3-ft-thick cover will be extended over these areas or the exceedance soil will be excavated and landfilled. The top 1 ft of the entire soil cover area will be constructed using uncontaminated soil from the on-post borrow areas.

The Section 36 Balance of Areas will also be covered with a variable-thickness soil cover. The former human health exceedance area is covered with a 2-ft-thick soil cover and the former potential risk to biota area is covered with a 1-ft-thick soil cover.

Soil posing risk to biota is generally excavated and consolidated within the Basin A and South Plants Central Area covers or placed beneath the Basin F cap. No action is undertaken for soil that potentially poses risks to biota that is located outside of this area, i.e., soil within the Lake Sediments or Surficial Soil Medium Groups. Although a residual risk to biota exists in these areas, the magnitude of the residual risk is comparatively low (see Section 6.2.4.3) and the short-term destruction of habitat is minimized. These areas are sampled periodically. No action (other than monitoring) is conducted for the aquatic lake sediments. Ongoing monitoring of the biota in these areas will be conducted in support of design refinement/design characterization.

The components of this alternative are summarized in Table 7.4-1. The total estimated cost for this alternative (in 1995 dollars) is $566 million (present worth cost of $401 million). A breakdown of capital and O&M costs for each component of this alternative is presented in Table 7.4-2. This alternative requires approximately 17 years for implementation.

7.4.3.5 Alternative 5 – Caps/Treatment/Landfill

Alternative 5 is composed of the following features: capping of 530 acres of contaminated soil, landfilling of 4 million BCY of soil and debris, and treatment of 1.1 million BCY of contaminated soil (Figure 7.4-5).

Approximately 1.1 million BCY of principal threat soil are treated by **thermal desorption**, **incineration**, or **solidification/stabilization**. The majority of the soil treated by thermal desorption is from the Basin F Wastepile, Former Basin F and South Plants Central Processing Area Subgroups. The excavation of soil from both the Basin F Wastepile and Former Basin F for treatment may require use of vapor- and odor- suppression measures. Soil in the Shell Trenches and Hex Pit Subgroups (103,000 BCY) is excavated and treated by incineration. The excavation of both the Shell Trenches and Hex Pit also requires use of vapor- and odor-suppression measures. All soil treated by thermal desorption or incineration is placed in the on-post hazardous waste landfill.

A total of 27,000 BCY of soil contaminated with inorganic contaminants are treated by solidification. The majority of the soil to be solidified is excavated from the Buried M-1 Pits Subgroup, which requires vapor- and odor-suppression measures during excavation.

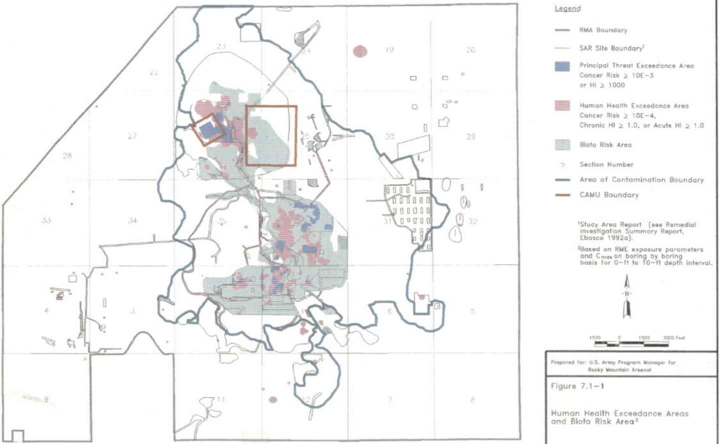
The Complex Trenches Subgroup is left in place and contained with a multilayer cap and slurry walls. The groundwater inside the contained area is pumped and treated as necessary.

Following the excavation of human health exceedance volumes for treatment or disposal, 530 acres in Section 36, the South Plants Central Processing Area, and the Former Basin F are capped (multilayer caps). Approximately 10.5 million BCY of borrow materials are required as gradefill to achieve the design grade for the caps, and an additional 3.9 million BCY of borrow are required for construction of the caps.

Approximately 4 million BCY of contaminated soil, primarily from sites outside of the central portions of RMA, as well as debris from UXO clearance operations, are landfilled under this alternative. The incinerated soil and debris and the thermally desorbed soil are also placed in the on-post hazardous waste landfill. Any agent-contaminated soil identified during screening is treated by caustic washing and then landfilled. In addition, any identified HE-filled and agent-filled UXO is excavated, packaged, and transported off post to an existing Army facility for detonation and disposal (unless the UXO is unstable and must be detonated on post) or other demilitarization process. The sanitary sewer manholes are plugged. The chemical sewers and any associated contaminated soil are excavated and placed in the on-post hazardous waste landfill. The 87,000 BCY of human health exceedance volume from the Surficial Soil Medium Group are also landfilled.

Soil posing risk to biota within the central six sections of RMA is generally excavated and landfilled. An additional 1,600 acres of soil representing a potential risk to the great horned owl are addressed through **agricultural practices**, which reduces the level of contamination in near-surface soil. No action other than monitoring is conducted for the aquatic lake sediments. Ongoing monitoring of biota in these areas will be conducted in support of design refinement/design characterization.

The components of this alternative are summarized in Table 7.4-1. The total estimated cost for this alternative (in 1995 dollars) is $1.01 billion (present worth cost of $542 million). A breakdown of capital and O&M costs for each component of this alternative is presented in Table 7.4-2. This alternative requires approximately 28 years for implementation.



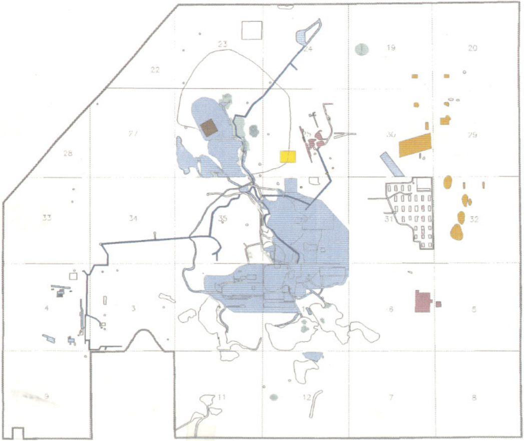
Prepared for: U.S. Army Program Manager for Rocky Mountain Arsenal

Figure 7.1-1

Human Health Exceedance Areas and Biota Risk Area[2]

Foster Wheeler Environmental Corporation
June 1996

File Name: C:\SOILS\RODVFIG711
Date 5/06/96
Drawn by XG
Checked by SA



Legend

RMA Boundary

SAR Site Boundary[1]

Capped Areas

Landfill Site

Areas to be Landfilled

Agent Screening Area (Caustic wash/landfill)

UXO Screening Area (Detonation/landfill)

Basin F Wastepile Cap

Access Restrictions

5 Section Number

[1]Study Area Report (see Remedial Investigation Summary Report, Ebasco 1992a).

-N-

1500 0 1500 3000 Feet

Prepared for: U.S. Army Program Manager for Rocky Mountain Arsenal

Figure 7.4–1

Caps/Covers Alternative

Foster Wheeler Environmental Corporation
June 1996

File Name: C:\SOILS\ROD\SOIL_ES1

Date 6/06/96

Drawn by XG

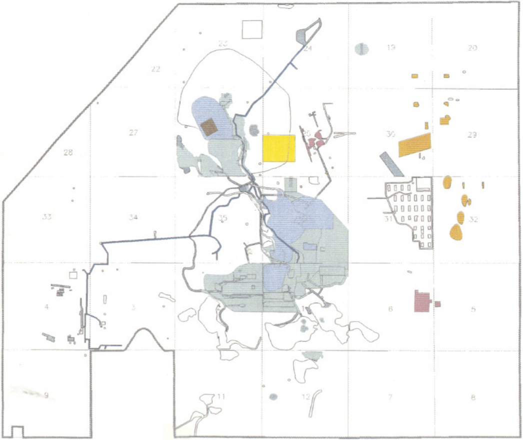
Checked by SA

File Name: C:\SOILS\ROD\SOIL_ES2

Date 6/06/96

Drawn by XG

Checked by SA



Legend

RMA Boundary

SAR Site Boundary[1]

Capped Areas

Landfill Site

Areas to be Landfilled

Agent Screening Area (Caustic wash/landfill)

UXO Screening Area (Detonation/landfill)

Basin F Wastepile Cap

Access Restrictions

5 Section Number

[1]Study Area Report (see Remedial Investigation Summary Report, Ebasco 1992a).

-N-

1500 0 1500 3000 Feet

Prepared for: U.S. Army Program Manager for Rocky Mountain Arsenal

Figure 7.4-2

Landfill/Caps Alternative

Foster Wheeler Environmental Corporation
June 1996

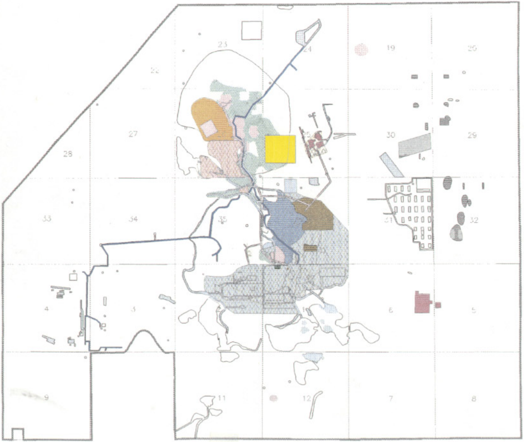
Prepared for: U.S. Army Program Manager for Rocky Mountain Arsenal

Figure 7.4-3

Landfill Alternative

Foster Wheeler Environmental Corporation
June 1996

File Name: C:\SOILS\ROD\SOIL_FS3
Date 6/06/96
Drawn by XG
Checked by SA



Legend

- RMA Boundary
- SAR Site Boundary[1]
- In-situ Solidification of Principal Threat Volume; RCRA-Equivalent Cap
- RCRA-Equivalent Caps
- Direct Solidification/Stabilization
- Innovative Thermal Treatment (Hex Pit)
- Basin A Consolidation Area
- Landfill Human Health Soil,[2] Consolidation of Biota Soil
- Landfill Human Health Soil[3]
- Landfill Site
- Soil Covers
- Agent Screening Area (Caustic wash/landfill)
- UXO Screening Area (Detonation/landfill)
- Surficial Soil Consolidation
- Access Restrictions
- 5 Section Number

[1] Study Area Report (see Remedial Investigation Summary Report, Ebasco 1992a)

[2] Debris from the Sanitary Landfills Medium Group will be consolidated.

[3] Wastepile material will be dried prior to landfilling, if necessary, to pass EPA paint filter test.

-N-

1500 0 1500 3000 Feet

Prepared for: U.S. Army Program Manager for Rocky Mountain Arsenal

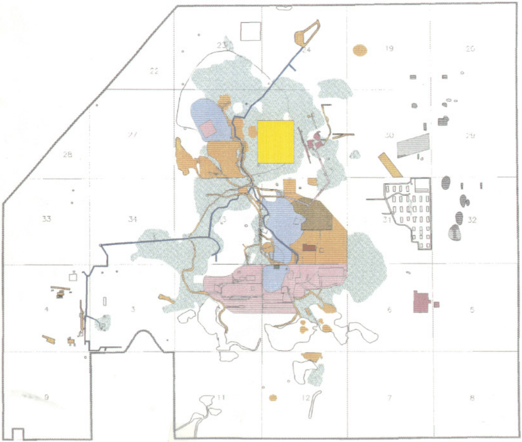
Figure 7.4-4

Consolidation/Caps/Treatment/ Landfill Alternative

Foster Wheeler Environmental Corporation
June 1996

File Name: C:\SOILS\ROD\SOIL_ES4
Date 6/06/96
Drawn by XG
Checked by SA

File Name: C:\SOILS\ROD\SOIL_ES5
Date 6/06/96
Drawn by XG
Checked by SA



Legend

- RMA Boundary
- SAR Site Boundary[1]
- Landfill and Cap following[2] Thermal Desorption of Principal Threat Volumes in Basin A, Former Basin F, South Plants Central Processing
- Thermal Desorption of Wastepile or Principal Threat Volume; Landfill
- Incineration
- Landfill Site
- Areas to be Landfilled
- Cap
- Direct Solidification/Stabilization
- Agent Screening Area (Caustic wash/landfill)
- UXO Screening Area (Detonation/landfill)
- In Situ Agricultural Practices
- Access Restrictions
- 5 Section Number

N

[1] Study Area Report (see Remedial Investigation Summary Report, Ebasco 1992a).

[2] Solidification/Stabilization of Principal Threat Volume with inorganic exceedance for South Plants Central Processing Area.

1500 0 1500 3000 Feet

Prepared for: U.S. Army Program Manager for Rocky Mountain Arsenal

Figure 7.4-5

Caps/Treatment/Landfill Alternative

Foster Wheeler Environmental Corporation
June 1996

Table 7.1-1 Description of Water Technologies[1]

Technology	Description
Dewatering	Dewatering involves the withdrawal of groundwater from an underground water-bearing zone, effectively lowering the water table in an area. A lower water table separates contamination in soil near the surface from groundwater. Prior to dewatering, groundwater levels are close to the ground surface. In areas of shallow groundwater, it is relatively easy for chemical spills or contaminants in soil near the surface to migrate down to the groundwater. Following dewatering, contaminated soil and groundwater are separated from each other and further contamination of groundwater is reduced. Dewatering is also used in construction and demolition activities in areas of shallow groundwater to stabilize subsurface soil. For example, before an old building and its basement can be demolished, the ground around it is dewatered. Once an area is dewatered, heavy equipment can be used and water is prevented from filling up the excavation. Dewatering also reduces the chances that the underground walls will cave in on workers.
Granular-Activated Carbon Adsorption	GAC adsorption refers to the removal of dissolved contaminants from an aqueous stream, although it may also be applied to gaseous streams. In the GAC process, water containing dissolved organic compounds is brought into contact with GAC, onto which the organic compounds preferentially adsorb. The attraction of organic molecules in solution to the surface of the carbon is dependent on the strength of the molecular attraction between the carbon and the organic contaminant, the molecular weight of the contaminant, the type and characteristics of the carbon, the surface area of the carbon, and the pH and temperature of the solution. The GAC process option can be used as a single treatment technology or as one of a series of treatments designed to optimally address a contaminant mixture in a treatment process train.
Air Stripping	Air stripping is an effective and proven method for removal of volatile organic compounds from water. The process involves the removal of the volatiles from an aqueous stream by mass transfer through countercurrent contact of the stream with air. Air stripping is a means for transferring the contamination from the liquid phase to gas (vapor). The gases are collected and require additional treatment.

Table 7.1-1 Description of Water Technologies[1]

Technology	Description
In Situ Biological Treatment	In situ biodegradation, or biological treatment, takes advantage of naturally occurring microorganisms in the aquifer that are capable of breaking down and destroying contaminants. In situ means "in place;" the term is appended to the name of this technology because the degradation occurs underground in the aquifer. The microorganisms that make this treatment technology work are already present in the aquifer, but they are not plentiful enough to significantly decrease the concentration of contaminants in the aquifer. To encourage their growth, oxygen and nutrients containing nitrogen are added to the aquifer. This is done by extracting some of the groundwater, adding chemicals to the water, and then reinjecting it into the aquifer. The microorganism population increases after the nutrients are added. The contaminants serve as a source of food for the microorganisms, with the result that the contaminants are destroyed.
Groundwater Extraction/Reinjection	Groundwater extraction methods may be used to collect contaminated groundwater from aquifers for surface treatment and reinjection, to dewater excavations in areas with a shallow water table, and/or to contain a plume of contaminated groundwater. The design of the extraction system is determined by site-specific conditions and the intended purpose of the system. For example, an intercept system may be designed to capture either the leading edge of a plume or the most contaminated portion of the plume. Under a mass-reduction approach, an extraction system is designed to capture the central mass or most contaminated portion of the plume. In addition to removing the mass of contamination, a mass reduction or dewatering approach eliminates contact between overlying contaminated soil and groundwater by lowering the water table. The layout, pumping rates, well spacing, etc., all differ for each of these examples depending on the desired effect. The groundwater extraction technology under consideration is extraction wells, with provisions for trenches/drains if needed. The reinjection method under consideration is a recharge trench. Extracted water is pumped to a treatment facility and the effluent from treatment is reinjected. Recharge trenches are excavated to a depth sufficient to convey water to the water table and may use any type of buried conduit used to convey liquids by gravity flow.

1 Detailed discussion of all water remediation technologies considered is presented in the Detailed Analysis of Alternatives report.

Table 7.1-2 Description of Structures Technologies[1]

Technology	Description
Structures Demolition	Structures demolition involves the physical dismantling of structures, sizing of debris, and separation of salvageable materials. Dismantling requires the use of medium to heavy equipment to demolish a structure, i.e., to take it apart piece by piece. The structure is broken up using bulldozers, backhoes, wrecking balls, clamshells, universal processors with cutting shears or other similar types of equipment. Contaminants are not treated through this process, but the volume is decreased and converted to a more workable form for subsequent treatment or disposal. Dust-control measures are commonly taken during the operation, generally consisting of spraying or misting water over the work area. Dismantling is applicable to all types and sizes of structures as well as pipes and tanks.
Salvage	Salvage consists of recycling scrap metal, process equipment, and piping. It represents an opportunity to reduce disposal costs and minimize waste streams. Materials that are salvaged include metal structure materials (rebar, support beams, etc.) and process equipment and piping. In addition, salvage includes the recycling of any metal materials that are stockpiled in "boneyards" on post. All metal materials from Army-owned structures are salvaged through the Defense Reutilization and Marketing Office. Metal materials may either be resold to salvage companies, recycled on or off post, or redistributed to Army facilities.
On-Post Landfill	A landfill securely contains contaminated structure debris by providing a physical barrier both above and below the contaminated material. The low-permeability cover protects human and biota receptors from direct contact with the contaminants, and the low-permeability liner restricts contaminant mobility, protecting the underlying soil and groundwater. The landfill technology is applicable primarily for the disposal of untreated soil and debris, but may also be used for the disposal of treated debris and soil/debris mixtures. In addition, oversize materials removed during materials-handling activities for both soil and structures treatment alternatives will also require placement in a landfill.
Caustic Washing of Agent-Contaminated Structure Debris	Caustic washing is a physical/chemical treatment process in which agent-contaminated structural debris is excavated, mixed with caustic wash fluids in an aboveground unit to degrade agent, and then separated from the fluids. The process is carried out at ambient temperature and atmospheric pressure. The makeup of the treatment solution is based upon suspected contaminants and suspected contaminant concentrations. At RMA this process is based upon the suspected presence of GB, VX, lewisite, and mustard. Although there are chemical treatment alternatives that more effectively treat each individual contaminant, this process has been designed to treat all aforementioned compounds and generate by-products of greatly reduced toxicity.

Table 7.1-2 Description of Structures Technologies[1]

Technology	Description
Multilayer Cap	A multilayer cap reduces both the migration of hazardous substances into the surrounding environment by minimizing deep percolation through the contaminated media and the potential for direct exposures by humans or biota to contaminated media through containment (i.e., the isolation of the contaminated media). From top to bottom, a multilayer cap generally consists of three layers: a 4-ft-thick soil/vegetation layer designed to minimize erosion and promote drainage; a 1-ft-thick layer of crushed concrete or cobbles as a biota barrier serving to protect the underlying low-permeability soil layer; and a 2-ft-thick layer of compacted, low-permeability soil. The cap is constructed with sufficient slope to prevent ponding of rainwater. The vegetation used for the top layer consists of locally adapted perennial grasses and low-growing plants selected to minimize erosion and discourage burrowing animals from using the cover as habitat.

1 Detailed discussion of all structures remediation technologies considered is presented in the Detailed Analysis of Alternatives report.

Table 7.1-3 Description of Soil Technologies[1]

Technology	Description
Excavation	Excavation is the removal of soil, debris, drums, pipes, tanks, or any other solid material from the ground. Examples of conventional excavation equipment are bulldozers, backhoes, clamshells, drag lines, front-end loaders, and scrapers. Excavated soil is loaded and transported to a disposal area or treatment facility. Backfilling (using on-post borrow material) and reclamation is required following excavation. Additional process requirements for excavation may include dust suppression, control of air emissions, dewatering, or removal of debris or UXO.
Soil Cover	A soil cover isolates the contaminated media from potential receptors, such as humans or biota, thereby preventing direct exposures through direct contact. A soil cover consists of a variable-thickness layer of soil and may include crushed or formed concrete layers as biota/excavation barriers. Soil covers may be sloped for erosion control and are vegetated with locally adapted perennial grasses and low-growing plants. A soil cover is not intended to provide a low-permeability barrier to infiltration.
Multilayer Cap	A multilayer cap reduces both the migration of hazardous substances into the surrounding environment by minimizing deep percolation through the contaminated media and the potential for direct exposures by humans or biota to contaminated media through containment (i.e., the isolation of the contaminated media). From top to bottom, a multilayer cap generally consists of three layers: a 4-ft-thick soil/vegetation layer designed to minimize erosion and promote drainage; a 1-ft-thick layer of crushed concrete or cobbles as a biota barrier to protect the underlying low-permeability soil layer; and a 2-ft-thick layer of compacted, low-permeability soil. The cap is constructed with sufficient slope to prevent ponding of rainwater. The vegetation used for the top layer consists of locally adapted perennial grasses and low-growing plants selected to minimize erosion and discourage burrowing animals from using the cover as habitat.
Slurry Wall	Slurry walls are vertical barriers that serve to impede the lateral flow of contaminated groundwater. The installation of a slurry wall entails the excavation of a trench, placement of the slurry mixture in the trench, and addition of fill material in the slurry-filled trench. The slurry wall mixture (commonly backfill soil, bentonite, and water) is selected based on compatibility and optimization concerns. The completed slurry wall acts as a low-permeability barrier to lateral groundwater flow. Slurry walls may be installed around sites in conjunction with a multilayer cap to form an isolation cell around the contaminated soil.

Table 7.1-3 Description of Soil Technologies[1]

Technology	Description
Composite Cap	A composite cap reduces both the migration of hazardous substances into the surrounding environment by minimizing infiltration through the contaminated soil and the potential for direct exposures by both humans and biota to contaminated media through containment (i.e., the isolation of the contaminated media). A composite cap consists of multiple layers including a soil/vegetative layer and a flexible-membrane liner overlying a layer of compacted clay. The composite cap design used in the soil alternatives includes a biota-intrusion barrier, drainage layers (sand and geotextile), and a geogrid for stability. The cap is constructed with sufficient slope to prevent ponding of rainwater, and the vegetation used for the top layer consists of locally adapted perennial grasses and low-growing plants selected to minimize erosion and discourage burrowing animals from using the cover as habitat.
On-Post Landfill	A landfill securely contains contaminated soil by providing a physical barrier both above and below the contaminated material. The low-permeability cover protects human and ecological receptors from direct contact with the contaminants, and the low-permeability liner restricts contaminant mobility, protecting the underlying soil and groundwater. The landfill technology is applicable primarily for the disposal of untreated soil and debris, but may also be used for the disposal of treated debris and soil/debris mixtures. In addition, oversize materials removed during materials handling activities for both soil and structures treatment alternatives will also require placement in a landfill.
Thermal Desorption	Thermal desorption uses heat to physically separate volatile (and some semivolatile) organic compounds from soil or sludge. In general, the operating temperature of the desorber (95°C to 540°C) is not high enough to oxidize or destroy the organic compounds to any significant extent, i.e., the desorber separates the organic contaminants so that the secondary combustion chamber may destroy them. Offgas from the secondary combustion chamber is treated for particulates and acid-gas emissions. Thermal desorption also volatilizes some metals; the extent of volatilization is a function of the selected operating temperature. For example, at the higher range of thermal desorption temperatures, mercury is almost entirely volatilized and arsenic is partially removed. Thermal desorption, however, cannot be used as a treatment technology for inorganic contaminant remediation.
Off-Post Demilitarization of UXO	Off-post demilitarization of UXO involves excavation, packaging, and transportation of the UXO to an appropriate Army facility for demilitarization. This process, applicable to any UXO identified involves shipping HE or agent-filled UXO that is safe or rendered safe to an Army facility specially designed for UXO demilitarization.

Table 7.1-3 Description of Soil Technologies[1]

Technology	Description
Caustic Washing of Agent-Contaminated Soil	Caustic washing is a physical/chemical treatment process in which agent-contaminated soil is excavated, mixed with caustic wash fluids in an aboveground unit to degrade agent, and then separated from the fluids. The process is carried out at ambient temperature and atmospheric pressure. The makeup of the treatment solution is based upon suspected contaminants and suspected contaminant concentrations. At RMA, this process is based upon the suspected presence of GB, VX, lewisite, and mustard. Although there are chemical treatment alternatives that more effectively treat each individual contaminant, this process has been designed to treat all aforementioned compounds and generate byproducts of greatly reduced toxicity.
Incineration	Incineration is a high-temperature process that uses either direct or indirect heat exchange to alter or destroy organic contaminants in soil, sludge, sediment, or debris. In general, the operating temperature of the incinerator (640°C to 1,000°C) is high enough to destroy the contaminants by oxidation or pyrolysis. Natural organic material is also burned out of the soil matrix. Incineration will remove, but not destroy, volatile metals such as mercury and arsenic. Off gas from the incinerator passes through a cyclone separator to remove particulates. Residual organic contaminants are destroyed in a secondary combustion chamber. Off gas from the secondary combustion chamber is treated for particulates and acid-gas emissions.
Stabilization/ Solidification	Solidification/stabilization processes use additives, or binding agents, to limit the mobility of contaminants and improve the physical characteristics of the waste by eliminating free liquids and producing a solid with high structural integrity. Although solidification/stabilization has historically addressed inorganic contamination through the use of cement-based agents, the advent of specialized additives has broadened the applicability to media containing both inorganic and organic contamination. Solidification/stabilization can be accomplished using ex situ or in situ processes. Ex situ processes rely on mechanical mixing equipment, such as a pug mill, to properly mix the contaminated soil with the binding agents. Mixing for in situ processes is accomplished using auger or rotor mixers. The binding agents are either placed on the soil surface and are drawn in by the mixing equipment or are injected through nozzles in the augers. An overlapping drilling pattern is used to obtain complete contact with the contaminated soil volume.
Agricultural Practices (Landfarming)	This technology consists of using landfarming techniques either with farm machinery (V-ripper, plow, and disk) or a soil stabilizer along with seeding to facilitate stabilization and attenuation of contaminants in surface soils (0-ft to 1 -ft depth interval). Mixing surface contamination with the soil below is expected to promote contaminant loss and to reduce both contaminant exposure to surface receptors and migration of contaminants by surface dust dispersion.

Table 7.1-3 Description of Soil Technologies[1]

Technology	Description
Pipe Plugging	This process option consists of filling the interior of pipes with grout. The purpose is to eliminate this contaminant migration pathway and immobilize contamination within the pipe, reducing its mobility. The technique involves using a mobile grout plant to mix and inject the plugging material into the pipe. The pipes to be plugged are first drained of any residual liquids, and any fittings that block the grout are cut from the pipe run. Aboveground pipe sections are cut into manageable lengths of 100 ft for diameters up to 12 inches and 50 ft for diameters up to 36 inches. The grout is pumped into the pipe run from the low end until it exits the high end, which is closed once grout starts coming out. The lower end is then closed off, and the grout is allowed to harden. Pumping grout from the low end to the high end helps to prevent the formation of voids.

1 Detailed discussion of all soil remediation technologies considered is presented in the Detailed Analysis of Alternatives report.

Table 7.1-4 Site Evaluation Criteria and Principal Threat Criteria for Soil

Contaminants of Concern	Principal Threat Criteria[2]	Chronic Risk-Based Criteria 0- to 1 0-ft Interval		Acute and Subchronic Risk-Based Criteria 0- to 1-ft Interval (where lower than chronic)
		Site Evaluation Criteria[2]	Preliminary Remediation Goals[2]	Site Evaluation Criteria[2]
Aldrin	720	71	0.72	3.8
Benzene	10,400	1,040	10	
Carbon Tetrachloride[1]	2,300	30	2.3	
Chlordane[1]	3,700	55	3.7	12
Chloroacetic Acid[1]	77,000	77	77	
Chlorobenzene[1]	850,000	850	850	
Chloroform[1]	48,000	370	48	
DDE	13,000	1,300	13	
DDT[1]	14,000	410	14	14
DBCD	200	8	0.2	
1,2-Dichloroethane	3,200	320	3.2	
1,1-Dichloroethene	520	52	0.52	
DCPD[1]	NA	3,700	3,700	
Dieldrin	410	41	0.41	3.7
Endrin[1]	230,000	230	230	56
HCCPD[1]	NA	1,100	1,100	
Isodrin[1]	52,000	52	52	
Methylene Chloride[1]	35,000	2,300	35	
1,1,2,2-Tetrachloroethane	1,500	150	1.5	
Tetrachloroethy lene[1]	5,400	410	5.4	
Toluene[1]	NA	7,200	7,200	
TCE	28,000	2,800	28	
Arsenic	4,200	420	4.2	270
Cadmium[1]	24,000	530	50	140
Chromium[1]	7,500	39	7.5	
Lead[1]	NA	2,200	2,200	
Mercury[1]	570,000	570	570	82

1 SEC based on noncarcinogenic PPLV.
2 Units presented in parts per million.

Table 7.1-5 Soil Exceedance Volumes by Medium Group[1,2]

Medium Group/Subgroup	Human Health Exceedance Volume[3] (BCY)	Principal Threat Exceedance Volume (BCY)	Excess Biota Volume; 0-1 ft (BCY)	Expected Agent Volume (BCY)	Expected UXO Volume (BCY)	UXO Debris Volume[4] (BCY)
Munitions Testing	0	0	0		450	89,000
North Plants	220	0	17,000	61		
Toxic Storage Yards	2,700	0	0	220		
Lake Sediments	19,000	0	19,000			
Ditches/Drainage	0	0	23,000			
Surficial Soil	87,000	1,500	460,000			
Basin A	160,000	32,000	88,000	710	94	47,000
Basin F Wastepile	600,000	600,000	0			
Secondary Basins	32,000	0	140,000			
Former Basin F	740,000	180,000	0			
Sanitary/Process Water Sewers	0	0	0			
Chemical Sewers	86,000	46,000	0	69		
Complex Trenches	400,000	400,000	0	1,300	1,300	130,000
Shell Trenches	100,000	100,000	0			
Hex Pit	3,300	3,300	0			
Sanitary Landfills[5]	14,000	0	23,000			
Section 36 Lime Basins	54,000	9,000	0	91		
Buried M-1 Pits	26,000	22,000	0	29		
S.P. Central Processing[6]	110,000	38,000	27,000	160		
S.P. Ditches	33,000	3,400	22,000			
S.P. Balance of Areas	130,000	11,000	510,000	160	50	5,000
Buried Sediments	16,000	0	0			
Sand Creek Lateral	15,000	0	90,000			
Section 36 Balance of Areas	64,000	0	140,000	300	160	78,000
Burial Trenches	28,000	0	0	12	550	57,000
Total	2,700,000	1,400,000	1,600,000	3,100	2,600	410,000

[1] All volumes presented to two significant figures. Detailed volume calculations are available in the administrative record (Foster Wheeler 1996).

[2] Individual volumes presented here may differ from those presented in the Detailed Analysis of Alternatives report (Volume IV, Appendix A) due to adjustments for overlap between exceedance categories. The total volume listed for each medium group remains consistent with those presented in the Detailed Analysis of Alternatives report.

[3] The human health exceedance volume includes the principal threat exceedance volume.

[4] The UXO debris volume includes human health exceedance volume as follows: Basin A, 16,500 BCY; Complex Trenches, 43,000 BCY; Section 36 Balance of Areas, 15,000 BCY; and Burial Trenches, 4,000 BCY.

[5] This medium group also contains 380,000 BCY of nonhazardous soil and debris.

[6] Exceedance volumes are based on a 5-ft depth cutoff due to difficulties in deeper excavation at this site. Additional exceedance volumes for the 5-ft to 10-ft depth interval are 32,000 BCY human health volume, including 17,000 BCY principal threat volume.

Table 7.1-6 Soil Exceedance Areas by Medium Group[1]

Medium Group/Subgroup	Human Health Exceedance Area (sy)	Principal Threat Exceedance Area (sy)	Excess Biota Area (sy)[2]	Potential Agent Area (sy)	Potential UXO Area (sy)
Munitions Testing	0	0	0		270,000
North Plants	330	0	50,000	28,000	
Toxic Storage Yards	1,700	0	0	130,000	
Lake Sediments	45,000	0	57,000		
Ditches/Drainage	0	0	70,000		
Surficial Soil	260,000	4,500	1,400,000		
Basin A	320,000	35,000	260,000	430,000	140,000
Basin F Wastepile	75,000	75,000	0		
Secondary Basins	92,000	0	410,000		
Former Basin F	350,000	110,000	0		
Sanitary/Process Water Sewers	0	0	0		
Chemical Sewers	100,000	49,000	0	76,000	
Complex Trenches	130,000	120,000	0	390,000	390,000
Shell Trenches	32,000	32,000	0		
Hex Pit	860	860	0		
Sanitary Landfills	12,000	0	69,000		
Section 36 Lime Basins	34,000	6,700	0	34,000	
Buried M-1 Pits	8,700	8,700	0	8,700	
S.P. Central Processing	140,000	42,000	80,000	98,000	
S.P. Ditches	50,000	5,500	65,000		
S.P. Balance of Areas	170,000	8,100	1,500,000	48,000	15,000
Buried Sediments	7,900	0	0		
Sand Creek Lateral	34,000	0	270,000		
Section 36 Balance of Areas	150,000	0	430,000	90,000	230,000
Burial Trenches	12,000	0	0	7,100	170,000
Total	2,000,000	500,000	4,700,000	1,300,000	1,200,000

[1] All areas presented to two significant figures. Detailed area calculations are available in the administrative record.

[2] Biota areas have been calculated to account for overlap with human health exceedance area and potential UXO area.

Table 7.2-1 Description of Water Alternatives

Alternative 1 Boundary Systems	Alternative 2 Boundary Systems / IRAs	Alternative 3 Boundary Systems / IRAs / Dewatering	Alternative 4 Boundary Systems / IRAs / Intercept Systems
Boundary systems continue to operate, but all on-post groundwater IRAs are dismantled. The ICS captures water from the Western Plume Group, the NWBCS captures water from the Northwest Boundary Plume Group, and the NBCS captures water from the North Boundary Plume Group.	Boundary systems continue to operate as in Alternative 1 and the on-post groundwater IRAs remain in operation. The IRAs include the two capture systems at the Motor Pool and Rail Yard area in the Western Plume Group that extract water and pump it for treatment at the ICS, the capture system north of Basin F in the North Boundary Plume Group that extracts water for treatment at the Basin A Neck System, and the Basin A Neck IRA that captures and treats water migrating from Basin A.	Boundary systems and IRAs continue to operate as in Alternative 2. Dewatering and treatment systems are installed to remove the contaminated central portions of the South Plants Plume Group and Basin A Plume Group groundwater. Dewatering accelerates lowering of the water table in South Plants and Basin A; the extracted water is treated in a new system. The South Tank Farm Plume in South Plants is treated separately by in situ biological treatment.	Boundary systems and IRAs continue to operate as in Alternative 2. Additionally, an extraction system is installed in the Section 36 Bedrock Ridge area to minimize contaminant migration from this part of the Basin A Plume Group. The extracted water is piped to the Basin A Neck system. Groundwater plumes in the South Plants area are monitored and lake-level maintenance or other means of hydaulic containment will be used to prevent South Plant plumes from migrating into the lakes at concentrations exceeding CBSGs.

Table 7.2-2 Capital and O&M Costs for Water Alternatives[1,2]

	Capital		Operating		Total	
Plume Group	Total Cost	PW Cost[3]	Total Cost	PW Cost[3]	Total Cost	PW Cost[3]
Alternative 1						
Northwest Boundary	0	0	32,500,000	21,500,000	32,500,000	21,500,000
Western	0	0	5,940,000	4,890,000	5,940,000	4,890,000
North Boundary	0	0	51,200,000	33,900,000	51,200,000	33,900,000
Basin A	28,500	28,500	3,280,000	2,340,000	3,308,500	2,368,500
South Plants	0	0	3,270,000	2,340,000	3,270,000	2,340,000
On-Post Water Supply[4]	15,000,000	14,600,000	0	0	15,000,000	14,600,000
Total	15,000,000	14,600,000	96,200,000	65,000,000	111,000,000	80,000,000
Alternative 2						
Northwest Boundary	0	0	32,500,000	21,500,000	32,500,000	21,500,000
Western	0	0	5,940,000	4,910,000	5,940,000	4,910,000
North Boundary	80,000	80,000	51,400,000	34,100,000	51,480,000	34,180,000
Basin A	0	0	30,700,000	20,500,000	30,700,000	20,500,000
South Plants	0	0	3,270,000	2,340,000	3,270,000	2,340,000
On-Post Water Supply[4]	15,000,000	14,600,000	0	0	15,000,000	14,600,000
Total	15,100,000	14,700,000	124,000	83,400,000	139,000,000	98,000,000
Alternative 3						
Northwest Boundary	0	0	32,500,000	21,500,000	32,500,000	21,500,000
Western	0	0	5,940,000	4,910,000	5,940,000	4,910,000
North Boundary	80,000	80,000	51,400,000	34,100,000	51,480,000	34,180,000
Basin A	7,050,000	6,940,000	41,300,000	27,600,000	48,350,000	34,540,000
South Plants	5,740,000	5,740,000	20,000,000	14,100,000	25,740,000	19,840,000
On-Post Water Supply[4]	15,000,000	14,600,000	0	0	15,000,000	14,600,000
Total	27,900,000	27,400,000	151,000,000	102,000,000	179,000,000	130,000,000
Alternative 4						
Northwest Boundary	0	0	32,500,000	21,500,000	32,500,000	21,500,000
Western	0	0	5,940,000	4,910,000	5,940,000	4,910,000
North Boundary	80,000	80,000	51,400,000	34,100,000	51,480,000	34,180,000
Basin A	3,540,000	3,540,000	29,800,000	19,800,000	33,340,000	23,340,000
South Plants	80,000	80,000	7,400,000	5,100,000	7,480,000	5,180,000
On-Post Water Supply[4]	15,000,000	14,600,000	0	0	15,000,000	14,600,000
Total	18,700,000	18,300,000	127,000,000	85,400,000	146,000,000	104,000,000

1 Detailed discussion of cost estimates is presented in the Detailed Analysis of Alternatives report.
2 All costs presented in 1995 dollars.
3 Present-worth calculations are based on a 3 percent discount rate.
4 Based on acquisition of a water supply of 1,500 acre-feet. Final on-post water requirements will be determined in the water management plan during remedial design.

Alternative 1 Landfill/Cap in Place	Alternative 2 Landfill/Consolidate	Alternative 3 Landfill
• *No Future Use, Significant Contamination History:* The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris disposed in the on-post hazardous waste landfill.	• *No Future Use, Significant Contamination History:* The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris disposed in the on-post hazardous waste landfill.	• *No Future Use, Significant Contamination History:* The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris disposed in the on-post hazardous waste landfill.
• *No Future Use, Other Contamination History:* The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris consolidated and capped (multilayer caps) in one of three places: the Rail Yard, North Plants, or the South Plants Central Processing Area.	• *No Future Use, Other Contamination History:* The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris disposed in the Basin A consolidation area.	• *No Future Use, Other Contamination History:* The structures are dismantled using dust controls, metals salvaged (if appropriate), and the remaining debris disposed in the on-post hazardous waste landfill.
• *No Future Use, Agent History:* The structures are dismantled using dust controls and air monitoring, the debris monitored for the presence of Army chemical agent and caustic washed as necessary, and the resulting debris disposed in the on-post hazardous waste landfill.	• *No Future Use, Agent History:* The structures are dismantled using dust controls and air monitoring, the debris monitored for the presence of Army chemical agent and caustic washed as necessary, and the resulting debris disposed in the on-post hazardous waste landfill.	• *No Future Use, Agent History:* The structures are dismantled using dust controls and air monitoring, the debris monitored for the presence of Army chemical agent and caustic washed as necessary, and the resulting debris disposed in the on-post hazardous waste landfill.

Table 7.3-2 Capital and O&M Costs for Structures Alternatives[1, 2]

Medium Group	Capital Total Cost	PW Cost[3]	Operating Total Cost	PW Cost[3]	Total Total Cost	PW Cost[3]
Alternative 1						
No Future Use, Significant Contamination History	1,088,000	1,014,000	13,206,000	12,252,000	14,294,000	13,266,000
No Future Use, Other Contamination History	72,000	68,000	38,728,000	35,685,000	38,800,000	35,753,000
No Future Use, Agent History	5,888,000	5,517,000	55,323,000	51,345,000	61,211,000	56,862,000
Total	7,048,000	6,599,000	107,257,000	99,282,000	114,000,000	106,000,000
Alternative 2						
No Future Use, Significant Contamination History	1,088,000	1,014,000	13,206,000	12,252,000	14,294,000	13,266,000
No Future Use, Other Contamination History	0	0	36,636,000	34,030,000	36,636,000	34,030,000
No Future Use, Agent History	5,888,000	5,517,000	55,323,000	51,345,000	61,211,000	56,862,000
Total	6,976,000	6,531,000	105,165,000	97,627,000	112,000,000	104,000,000
Alternative 3						
No Future Use, Significant Contamination History	1,088,000	1,014,000	13,206,000	12,252,000	14,294,000	13,266,000
No Future Use, Other Contamination History	4,112,000	3,834,000	37,847,000	35,098,000	41,959,000	38,932,000
No Future Use, Agent History	5,888,000	5,517,000	55,323,000	51,345,000	61,211,000	56,862,000
Total	11,088,000	10,365,000	106,376,000	98,695,000	118,000,000	109,000,000

1 Detailed discussion of cost estimates is presented in the Detailed Analysis of Alternatives report.
2 All costs presented in 1995 dollars.
3 Present-worth calculations are based on a 3 percent discount rate.

Table 7.4-1 Description of Soil Alternatives

Medium Groups/ Subgroups	Alternative 1 Caps/Covers[1]	Alternative 2 Landfill/Caps[1]	Alternative 3 Landfill[1]	Alternative 4 Consolidation/Caps/ Treatment/Landfill	Alternative 5 Caps/Treatment/ Landfill[1]
Munitions Testing	Munitions screening; off-post detonation of UXO; landfill debris and soil above TCLP.	Munitions screening; off-post detonation of UXO; landfill debris and soil above TCLP.	Munitions screening; off-post detonation of UXO; landfill debris and soil above TCLP.	Munitions screening; off-post detonation of UXO; landfill debris and soil above TCLP.	Munitions screening; off-post detonation of UXO; landfill debris and soil above TCLP.
North Plants	Landfill human health exceedance; agent monitoring during excavation; caustic washing; install soil cover over soil posing risk to biota and processing area.	Landfill human health exceedance; agent monitoring during excavation; caustic washing; install soil cover over soil posing risk to biota and processing area.	Landfill human health exceedance; agent monitoring during excavation; caustic washing; install soil cover over soil posing risk to biota and processing area.	Landfill human health exceedance; agent monitoring during excavation; caustic washing; install soil cover over soil posing risk to biota and processing area.	Landfill human health exceedance; agent monitoring during excavation; caustic washing; install soil cover over soil posing risk to biota and processing area.
Toxic Storage Yards	Landfill human health exceedance; utilize New Toxic Storage Yard for borrow area; agent monitoring during excavation and site preparation; caustic washing.	Landfill human health exceedance; utilize New Toxic Storage Yard for borrow area; agent monitoring during excavation and site preparation; caustic washing.	Landfill human health exceedance; utilize New Toxic Storage Yard for borrow area; agent monitoring during excavation and site preparation; caustic washing.	Landfill human health exceedance; utilize New Toxic Storage Yard for borrow area; agent monitoring during excavation and site preparation; caustic washing.	Landfill human health exceedance; utilize New Toxic Storage Yard for borrow area; agent monitoring during excavation and site preparation; caustic washing.
Lake Sediments	Landfill human health exceedances; additional action determined by Parties based on continuing monitoring of biota in these areas.	Landfill human health exceedances; additional action determined by Parties based on continuing monitoring of biota in these areas.	Landfill human health exceedances and soil posing risk to biota (Upper Derby Lake); deferral to USFWS for aquatic sediments.	Landfill human health exceedances and consolidate soil posing risk to biota (Upper Derby Lake); deferral to USFWS for aquatic sediments.	Landfill human health exceedances and soil posing risk to biota (Upper Derby Lake); deferral to USFWS for aquatic sediments.

Medium Groups/ Subgroups	Alternative 1 Caps/Covers[1]	Alternative 2 Landfill/Caps[1]	Alternative 3 Landfill[1]	Alternative 4 Consolidation/Caps/ Treatment/Landfill	Alternative 5 Caps/Treatment/ Landfill[1]
Surficial Soil	Landfill human health exceedances; additional action determined by Parties based on continuing monitoring of biota in these areas.	Landfill human health exceedances; additional action determined by Parties based on continuing monitoring of biota in these areas.	Landfill human health exceedances; additional action determined by Parties based on continuing monitoring of biota in these areas.	Landfill human health exceedances; consolidate soil posing risk to biota in Basin A, Former Basin F, and South Plants; additional action determined by Parties based on continuing monitoring of biota in these areas.	Agricultural practices for soil posing risks to biota and landfill human health exceedances.
Ditches/Drainage Areas	Additional action determined by Parties based on continuing monitoring of biota in these areas.	Additional action determined by Parties based on continuing monitoring of biota in these areas.	Landfill soil posing risk to biota.	Consolidate soil posing risk to biota in Basin A.	Landfill soil posing risk to biota.
Basin A	Cap principal threat and human health exceedances and soil posing risk to biota.	Cap principal threat and human health exceedances and soil posing risk to biota.	Landfill principal threat and human health exceedances; cap entire site including soil posing risk to biota.[2]	Construct soil cover with concrete barrier over principal threat and human health exceedances and soil posing risk to biota; consolidate soil posing risk to biota/structural debris from other sites.	Thermal desorption of principal threat soil; landfill human health including treated soil; cap entire site including soil posing risk to biota.[2]
Basin F Wastepile	Modify existing cap according to RCRA requirements (composite cap).	Modify existing cap according to RCRA requirements (composite cap).	Modify existing cap according to RCRA requirements (composite cap).	Landfill entire wastepile (principal threat exceedance) in triple-lined cell (excavate with vapor control) after drying saturated materials.	Thermal desorption of entire wastepile (principal threat exceedance) (excavate with vapor control); landfill treated soil.

Medium Groups/ Subgroups	Alternative 1 Caps/Covers[1]	Alternative 2 Landfill/Caps[1]	Alternative 3 Landfill[1]	Alternative 4 Consolidation/Caps/ Treatment/Landfill	Alternative 5 Caps/Treatment/ Landfill[1]
Former Basin F	Modify existing cap to RCRA-equivalent cap.	Modify existing cap to RCRA-equivalent cap.	Landfill principal threat and human health exceedances (excavate under vapor enclosure); cap entire site.	In situ solidification/ stabilization of principal threat exceedance volume; cap entire site with RCRA-equivalent cap.	Thermal desorption of principal threat soil (excavate under vapor enclosure); landfill human health exceedances including treated soil; cap entire site.
Secondary Basins	Cap human health exceedances and soil posing risk to biota.	Landfill human health exceedances and soil posing risk to biota.	Landfill human health exceedances and soil posing risk to biota.	Landfill human health exceedances; install soil cover over soil posing risk to biota.	Landfill human health exceedances and soil posing risk to biota.
Sanitary/Process Water Sewers	Plug remaining manholes.	Plug remaining manholes.	Landfill sewer lines.	Plug remaining manholes.	Plug remaining manholes.
Chemical Sewers	Plug sewer lines.	Plug sewer lines in South Plants Central Processing Area and Complex Trenches; landfill remaining principal threat and human health exceedances.[2]	Landfill principal threat and human health exceedances.[2]	Plug sewer lines in South Plants Central Processing Area and Complex Trenches; landfill remaining principal threat and human health exceedances.[2]	Thermal desorption of principal threat soil; landfill human health exceedances including treated principal threat soil.[2]
Complex Trenches	Cap principal threat and human health exceedances and soil posing risk to biota and install a slurry wall around disposal trenches.	Cap principal threat and human health exceedances and soil posing risk to biota and install a slurry wall around disposal trenches.	Cap principal threat and human health exceedances and soil posing risk to biota and install a slurry wall around disposal trenches.	Cap (RCRA-equivalent cap with concrete barrier) principal threat and human health exceedances and soil posing risk to biota and install a slurry wall around disposal trenches.	Cap principal threat and human health exceedances and soil posing risk to biota and install a slurry wall around disposal trenches.

Medium Groups/ Subgroups	Alternative 1 Caps/Covers[1]	Alternative 2 Landfill/Caps[1]	Alternative 3 Landfill[1]	Alternative 4 Consolidation/Caps/ Treatment/Landfill	Alternative 5 Caps/Treatment/ Landfill[1]
Shell Trenches	Modify existing cover and install slurry wall around trenches.	Modify existing cover and install slurry wall around trenches.	Landfill trenches after materials handling (excavate with vapor control).	Modify existing cover to be RCRA-equivalent cap and modify existing slurry wall around trenches.	Incinerate trenches; landfill treated soil (excavate with vapor control).
Hex Pit	Install cap and slurry wall around trenches.	Install cap and slurry wall around trenches.	Landfill disposal pit after materials handling (excavate with vapor control).	Treatment of approximately 1,000 bcy of principal threat material using an innovative thermal technology and landfill remaining soil (excavate with vapor control). Treatment will be revised to a solidification/ stabilization technology if all evaluation criteria for the innovative thermal technology are not met.	Incinerate disposal pit; landfill treated soil (excavate with vapor control).
Sanitary Landfills	Cap entire site.	Landfill human health exceedances, debris, and soil posing risk to biota.	Landfill human health exceedances, debris, and soil posing risk to biota.	Landfill human health exceedances; consolidate debris and soil posing risk to biota in Basin A.	Landfill human health exceedances, debris, and soil posing risk to biota.
Section 36 Lime Basins	Modify existing cover.	Modify existing cover.	Landfill principal threat and human health exceedances; cap entire site.[2]	Landfill principal threat and human health exceedances in triple-lined cell; repair existing soil cover.[2]	Landfill principal threat and human health exceedances; cap entire site.[2]

Table 7.4-1 Description of Soil Alternatives

Medium Groups/ Subgroups	Alternative 1 Caps/Covers[1]	Alternative 2 Landfill/Caps[1]	Alternative 3 Landfill[1]	Alternative 4 Consolidation/Caps/ Treatment/Landfill	Alternative 5 Caps/Treatment/ Landfill[1]
Buried M-1 Pits	Install cap and slurry wall around entire site.	Install cap and slurry wall around entire site.	Landfill principal threat and human health exceedances (excavate with vapor control).[2]	Solidification/ stabilization and landfill of principal threat and human health exceedances (excavate with vapor control).[2]	Solidification/ stabilization and landfill of principal threat and human health exceedances (excavate with vapor control).[2]
South Plants Central Processing Area	Cap principal threat and human health exceedances and soil posing risk to biota.	Cap principal threat and human health exceedances and soil posing risk to biota.	Landfill principal threat and human health exceedances; cap entire site including soil posing risk to biota.[2]	Landfill principal threat and human health exceedances (excavate to depth of 5 feet); construct soil cover with biota barrier over entire site including soil posing risk to biota; consolidate soil posing risk to biota from other South Plants sites.[2]	Thermal desorption and solidification of principal threat exceedances; landfill human health exceedances including treated soil; cap entire site including soil posing risk to biota.[2]
South Plants Ditches	Cap principal threat and human health exceedances and soil posing risk to biota.	Landfill principal threat and human health exceedances and soil posing risk to biota.	Landfill principal threat and human health exceedances and soil posing risk to biota.	Landfill principal threat and human health exceedances; consolidate soil posing risk to biota into excavated areas; install soil cover (variable thickness) over entire site.	Thermal desorption of principal threat soil; landfill human health exceedances, including treated soil and soil posing risk to biota.
South Plants Balance of Areas	Cap principal threat and human health exceedances and soil posing risk to biota.	Landfill principal threat and human health exceedances and soil posing risk to biota.[2,3]	Landfill principal threat and human health exceedances and soil posing risk to biota.[2,3]	Landfill principal threat and human health exceedances; consolidate soil posing risk to biota into excavated areas; install soil cover (variable thickness) over entire site.[2,3]	Thermal desorption of principal threat soil; landfill human health exceedances, including treated soil and soil posing risk to biota.[2,3]

Medium Groups/ Subgroups	Alternative 1 Caps/Covers[1]	Alternative 2 Landfill/Caps[1]	Alternative 3 Landfill[1]	Alternative 4 Consolidation/Caps/ Treatment/Landfill	Alternative 5 Caps/Treatment/ Landfill[1]
Buried Sediments	Cap human health exceedances.	Landfill human health exceedances.	Landfill human health exceedances.	Landfill human health exceedances.	Landfill human health exceedances.
Sand Creek Lateral	Cap human health exceedances and soil posing risk to biota.	Landfill human health exceedances and soil posing risk to biota.	Landfill human health exceedances and soil posing risk to biota.	Landfill human health exceedances; consolidate soil posing risk to biota into Basin A.	Landfill human health exceedances and soil posing risk to biota.
Section 36 Balance of Areas	Cap human health exceedances and soil posing risk to biota.	Landfill human health exceedances and soil posing risk to biota.[2,3]	Landfill human health exceedances and soil posing risk to biota.[2,3]	Landfill human health exceedances; consolidate soil posing risk to biota into Basin A; install soil cover (variable thickness) over entire site.[2,3]	Landfill human health exceedances and soil posing risk to biota.[2,3]
Burial Trenches	Landfill human health exceedances.[2,3]	Landfill human health exceedances.[2,3]	Landfill human health exceedances.[2,3]	Landfill human health exceedances.[2,3]	Landfill human health exceedances.[2,3]

[1] Cap consists of a clay/soil cap unless otherwise noted.

[2] Agent monitoring during excavation and treatment of any soil containing agent by caustic washing.

[3] Munitions screening prior to excavation, off-post detonation of any munitions encountered, and landfilling of munitions debris and associated soil above TCLP.

Table 7.4-2 Capital and O&M Costs for Soil Alternatives[1]

	Capital Cost		O&M Cost		Total Cost	
Medium Group/Subgroup	Total Cost	Present Worth[2]	Total Cost	Present Worth[2]	Total Cost	Present Worth[2]
Sitewide Alternative I - Caps/Covers						
Munitions Testing	$ 7,110,000	$ 6,150,000	$ 713,000	$ 296,000	$ 7,820,000	$ 6,450,000
North Plants	$ 2,370,000	$ 1,770,000	$ 1,610,000	$ 670,000	$ 3,980,000	$ 2,440,000
Toxic Storage Yards	$ 4,310,000	$ 3,720,000	$ 1,330,000	$ 554,000	$ 5,640,000	$ 4,270,000
Lake Sediments	$ 3,350,000	$ 2,160,000	$ 154,000	$ 63,800	$ 3,500,000	$ 2,220,000
Surficial Soil	$ 12,420,000	$ 8,470,000	$ 680,000	$ 282,000	$ 13,100,000	$ 8,750,000
Ditches/Drainage Areas	$	$	$	$	$	$ -
Basin A	$ 58,400,000	$ 52,000,000	$ 3,580,000	$ 1,490,000	$ 61,980,000	$ 53,500,000
Basin F Wastepile	$ 8,160,000	$ 5,920,000	$ 6,360,000	$ 2,640,000	$ 14,500,000	$ 8,560,000
Secondary Basins	$ 53,900,000	$ 34,100,000	$ 2,930,000	$ 1,220,000	$ 56,800,000	$ 35,300,000
Former Basin F	$ 36,300,000	$ 24,400,000	$ 2,730,000	$ 1,130,000	$ 39,000,000	$ 25,500,000
Sanitary/Process Water Sewers	$ 344,000	$ 280,000	$ -	$	$ 344,000	$ 280,000
Chemical Sewers	$ 853,000	$ 719,000	$ 2,720,000	$ 1,130,000	$ 3,570,000	$ 1,850,000
Complex Trenches	$ 38,400,000	$ 26,600,000	$ 6,970,000	$ 2,900,000	$ 45,400,000	$ 29,500,000
Shell Trenches	$ 2,930,000	$ 2,400,000	$ 2,650,000	$ 1,100,000	$ 5,580,000	$ 3,500,000
Hex Pit	$ 676,000	$ 588,000	$ 984,000	$ 409,000	$ 1,660,000	$ 1,000,000
Sanitary Landfills	$ 14,300,000	$ 10,300,000	$ 1,000,000	$ 416,000	$ 15,300,000	$ 10,700,000
Section 36 Lime Basins	$ 4,520,000	$ 3,280,000	$ 1,200,000	$ 498,000	$ 5,720,000	$ 3,780,000
Buried M-1 Pits	$ 1,660,000	$ 1,450,000	$ 1,020,000	$ 422,000	$ 2,680,000	$ 1,870,000
South Plants Central Processing Area	$ 26,400,000	$ 21,500,000	$ 1,820,000	$ 757,000	$ 28,200,000	$ 22,300,000
South Plants Ditches	$ 8,590,000	$ 6,600,000	$ 1,410,000	$ 586,000	$ 10,000,000	$ 7,190,000
South Plants Balance Of Areas	$ 126,000,000	$ 96,800,000	$ 7,730,000	$ 3,210,000	$ 134,000,000	$ 100,000,000
Buried Sediments	$ 3,380,000	$ 2,840,000	$ 994,000	$ 413,000	$ 4,370,000	$ 3,250,000
Sand Creek Lateral	$ 16,500,000	$ 10,900,000	$ 2,160,000	$ 897,000	$ 18,700,000	$ 11,800,000
Section 36 Balance Of Areas	$ 46,800,000	$ 33,300,000	$ 3,900,000	$ 1,620,000	$ 50,700,000	$ 34,900,000
Burial Trenches	$ 8,190,000	$ 6,680,000	$ 772,000	$ 321,000	$ 8,960,000	$ 7,000,000
Total	$ 486,000,000	$ 363,000,000	$ 55,400,000	$ 23,000,000	$ 542,000,000	$ 386,000,000

Table 7.4-2 Capital and O&M Costs for Soil Alternatives[1]

	Capital Cost		O&M Cost		Total Cost	
Medium Group/Subgroup	Total Cost	Present Worth[2]	Total Cost	Present Worth[2]	Total Cost	Present Worth[2]
Sitewide Alternative 2 - Landfill/Caps						
Munitions Testing	$5,930,000	$5,130,000	$258,000	$110,000	$6,190,000	$5,240,000
North Plants	$2,160,000	$1,610,000	$1,360,000	$581,000	$3,520,000	$2,190,000
Toxic Storage Yards	$3,230,000	$2,790,000	$391,000	$167,000	$3,620,000	$2,960,000
Lake Sediments	$3,100,000	$2,000,000	$55,600	$23,800	$3,160,000	$2,020,000
Surficial Soil	$11,400,000	$7,510,000	$246,000	$105,000	$11,600,000	$7,620,000
Ditches/Drainage Areas	$0	$0	$0	$0	$0	$0
Basin A	$55,900,000	$49,000,000	$3,580,000	$1,530,000	$59,500,000	$50,500,000
Basin F Wastepile	$8,280,000	$6,190,000	$6,360,000	$2,720,000	$14,600,000	$8,910,000
Secondary Basins	$12,900,000	$8,290,000	$487,000	$208,000	$13,400,000	$8,500,000
Former Basin F	$38,200,000	$25,600,000	$2,730,000	$1,170,000	$40,900,000	$26,800,000
Sanitary/Process Water Sewers	$344,000	$280,000	$0	$0	$344,000	$280,000
Chemical Sewers	$12,000,000	$10,000,000	$608,000	$260,000	$12,600,000	$10,260,000
Complex Trenches	$40,100,000	$27,700,000	$6,970,000	$2,980,000	$47,100,000	$30,700,000
Shell Trenches	$2,980,000	$2,440,000	$2,650,000	$1,140,000	$5,630,000	$3,580,000
Hex Pit	$677,000	$590,000	$984,000	$421,000	$1,660,000	$1,010,000
Sanitary Landfills	$29,700,000	$21,500,000	$1,210,000	$520,000	$30,900,000	$22,000,000
Section 36 Lime Basins	$4,680,000	$3,490,000	$1,200,000	$513,000	$5,880,000	$4,000,000
Buried M-1 Pits	$1,680,000	$1,420,000	$1,020,000	$435,000	$2,700,000	$1,860,000
South Plants Central Processing Area	$17,400,000	$13,800,000	$1,820,000	$780,000	$19,200,000	$14,600,000
South Plants Ditches	$4,780,000	$3,670,000	$162,000	$69,400	$4,940,000	$3,740,000
South Plants Balance Of Areas	$47,600,000	$36,000,000	$2,130,000	$912,000	$49,700,000	$36,900,000
Buried Sediments	$1,890,000	$1,590,000	$45,400	$19,400	$1,940,000	$1,610,000
Sand Creek Lateral	$9,370,000	$6,200,000	$303,000	$130,000	$9,670,000	$6,330,000
Section 36 Balance Of Areas	$26,100,000	$18,600,000	$1,350,000	$576,000	$27,500,000	$19,200,000
Burial Trenches	$6,900,000	$5,460,000	$266,000	$114,000	$7,170,000	$5,570,000
Total	$347,000,000	$261,000,000	$36,200,000	$15,500,000	$383,000,000	$276,000,000

Table 7.4-2 Capital and O&M Costs for Soil Alternatives[1]

Medium Group/Subgroup	Capital Cost Total Cost	Capital Cost Present Worth[2]	O&M Cost Total Cost	O&M Cost Present Worth[2]	Total Cost Total Cost	Total Cost Present Worth[2]
Sitewide Alternative 3 - Landfill						
Munitions Testing	$5,790,000	$4,860,000	$197,000	$70,700	$5,990,000	$4,930,000
North Plants	$2,120,000	$1,590,000	$1,310,000	$470,000	$3,430,000	$2,060,000
Toxic Storage Yards	$3,030,000	$2,620,000	$215,000	$77,000	$3,250,000	$2,700,000
Lake Sediments	$4,320,000	$2,550,000	$84,500	$30,300	$4,400,000	$2,580,000
Surficial Soil	$11,200,000	$7,440,000	$188,000	$67,500	$11,400,000	$7,510,000
Ditches/Drainage Areas	$4,270,000	$2,830,535	$114,000	$40,854	$4,380,000	$2,870,000
Basin A	$74,300,000	$61,600,000	$4,810,000	$1,720,000	$79,100,000	$63,300,000
Basin F Wastepile	$8,310,000	$5,850,000	$6,360,000	$2,280,000	$14,700,000	$8,130,000
Secondary Basins	$12,700,000	$7,450,000	$373,000	$134,000	$13,100,000	$7,600,000
Former Basin F	$138,000,000	$85,900,000	$4,450,000	$1,600,000	$142,000,000	$87,500,000
Sanitary/Process Water Sewers	$10,300,000	$8,390,000	$26,600	$9,516	$10,300,000	$8,400,000
Chemical Sewers	$17,800,000	$14,900,000	$415,000	$149,000	$18,200,000	$15,000,000
Complex Trenches	$40,600,000	$22,800,000	$6,970,000	$2,500,000	$47,600,000	$25,300,000
Shell Trenches	$35,300,000	$24,100,000	$221,000	$79,300	$35,500,000	$24,200,000
Hex Pit	$4,770,000	$4,020,000	$7,300	$2,620	$4,780,000	$4,020,000
Sanitary Landfills	$30,000,000	$16,100,000	$929,000	$333,000	$30,900,000	$16,400,000
Section 36 Lime Basins	$10,100,000	$7,130,000	$1,430,000	$511,000	$11,500,000	$7,640,000
Buried M-1 Pits	$6,890,000	$5,800,000	$83,900	$30,100	$6,970,000	$5,830,000
South Plants Central Processing Area	$28,600,000	$21,900,000	$2,270,000	$815,000	$30,900,000	$22,700,000
South Plants Ditches	$4,710,000	$3,510,000	$124,000	$44,500	$4,830,000	$3,550,000
South Plants Balance Of Areas	$46,600,000	$34,000,000	$1,570,000	$562,000	$48,200,000	$34,600,000
Buried Sediments	$1,870,000	$1,530,000	$34,800	$12,500	$1,900,000	$1,540,000
Sand Creek Lateral	$9,230,000	$6,110,000	$232,000	$83,200	$9,460,000	$6,190,000
Section 36 Balance Of Areas	$25,500,000	$14,800,000	$914,000	$328,000	$26,400,000	$15,100,000
Burial Trenches	$6,770,000	$4,490,000	$199,000	$71,200	$6,970,000	$4,560,000
Total	$543,000,000	$372.000.000	$33.500.000	$12.000.000	$576,000,000	$384,000,000

Table 7.4-2 Capital and O&M Costs for Soil Alternatives[1]

Medium Group/Subgroup	Capital Cost Total Cost	Capital Cost Present Worth[2]	O&M Cost Total Cost	O&M Cost Present Worth[2]	Total Cost Total Cost	Total Cost Present Worth[2]
Sitewide Alternative 4 - Consolidation/Caps/Treatment/Landfill						
Munitions Testing	$6,150,000	$5,320,000	$379,000	$157,000	$6,530,000	$5,480,000
North Plants	$2,120,000	$1,580,000	$1,340,000	$557,000	$3,460,000	$2,140,000
Toxic Storage Yards	$3,160,000	$2,730,000	$334,000	$139,000	$3,490,000	$2,870,000
Lake Sediments	$3,790,000	$2,440,000	$81,700	$33,900	$3,870,000	$2,470,000
Surficial Soil	$20,000,000	$13,500,000	$361,000	$150,000	$20,400,000	$13,700,000
Ditches/Drainage Areas	$2,410,000	$1,600,000	$0	$0	$2,410,000	$1,600,000
Basin A	$52,900,000	$42,500,000	$4,330,000	$1,800,000	$57,200,000	$44,300,000
Basin F Wastepile	$130,000,000	$92,300,000	$2,180,000	$904,000	$132,000,000	$93,200,000
Secondary Basins	$7,840,000	$5,350,000	$2,010,000	$835,000	$9,850,000	$6,190,000
Former Basin F	$83,200,000	$52,800,000	$4,210,000	$1,750,000	$87,400,000	$54,600,000
Sanitary/Process Water Sewers	$344,000	$289,000	$0	$0	$344,000	$289,000
Chemical Sewers	$12,000,000	$10,400,000	$619,000	$257,000	$12,600,000	$10,700,000
Complex Trenches	$47,000,000	$31,100,000	$8,370,000	$3,480,000	$55,400,000	$34,600,000
Shell Trenches	$2,850,000	$2,330,000	$3,400,000	$1,410,000	$6,250,000	$3,740,000
Hex Pit	$5,180,000	$4,480,000	$9,800	$4,100	$5,190,000	$4,480,000
Sanitary Landfills	$14,600,000	$11,200,000	$58,600	$24,300	$14,700,000	$11,200,000
Section 36 Lime Basins	$8,170,000	$6,090,000	$326,000	$135,000	$8,500,000	$6,230,000
Buried M-1 Pits	$24,000,000	$20,100,000	$192,000	$79,800	$24,200,000	$20,200,000
South Plants Central Processing Area	$18,900,000	$15,400,000	$2,950,000	$1,220,000	$21,900,000	$16,600,000
South Plants Ditches	$3,020,000	$2,390,000	$142,000	$58,900	$3,160,000	$2,450,000
South Plants Balance Of Areas	$34,900,000	$27,600,000	$4,960,000	$2,060,000	$39,900,000	$29,700,000
Buried Sediments	$1,830,000	$1,540,000	$66,800	$27,700	$1,900,000	$1,570,000
Sand Creek Lateral	$4,720,000	$3,130,000	$62,400	$25,900	$4,780,000	$3,160,000
Section 36 Balance Of Areas	$19,100,000	$13,600,000	$3,500,000	$1,450,000	$22,600,000	$15,100,000
Burial Trenches	$7,100,000	$6,140,000	$377,000	$157,000	$7,480,000	$6,300,000
Contingent Soil Volume	$9,860,000	$8,020,000	$637,000	$265,000	$10,500,000	$8,300,000
Total	$525,000,000	$384.000,000	$40,900,000	$17,000,000	$566,000,000	$401,000,000

Table 7.4-2 Capital and O&M Costs for Soil Alternatives[1]

Medium Group/Subgroup	Capital Cost: Total Cost	Capital Cost: Present Worth[2]	O&M Cost: Total Cost	O&M Cost: Present Worth[2]	Total Cost: Total Cost	Total Cost: Present Worth[2]
Sitewide Alternative 5 - Caps/Treatment/Landfill						
Munitions Testing	$5,710,000	$4,800,000	$174,000	$52,300	$5,880,000	$4,850,000
North Plants	$2,130,000	$1,590,000	$1,310,000	$393,000	$3,440,000	$1,980,000
Toxic Storage Yards	$3,020,000	$2,610,000	$214,000	$64,100	$3,230,000	$2,670,000
Lake Sediments	$4,300,000	$2,000,000	$74,600	$22,400	$4,370,000	$2,020,000
Surficial Soil	$11,700,000	$6,680,000	$166,000	$49,900	$11,900,000	$6,730,000
Ditches/Drainage Areas	$4,230,000	$2,570,000	$101,000	$30,200	$4,330,000	$2,600,000
Basin A	$73,300,000	$50,200,000	$13,300,000	$4,000,000	$86,600,000	$54,200,000
Basin F Wastepile	$87,200,000	$63,000,000	$206,000,000	$61,900,000	$293,000,000	$125,000,000
Secondary Basins	$ 12,500,000	$6,550,000	$329,000	$98,800	$12,800,000	$6,650,000
Former Basin F	$151,000,000	$98,600,000	$53,400,000	$16,000,000	$204,000,000	$115,000,000
Sanitary/Process Water Sewers	$344,000	$297,000	$0	$0	$344,000	$297,000
Chemical Sewers	$19,200,000	$16,100,000	$12,800,000	$3,850,000	$32,000,000	$20,000,000
Complex Trenches	$40,800,000	$22,900,000	$6,970,000	$2,090,000	$47,800,000	$25,000,000
Shell Trenches	$52,000,000	$31,100,000	$37,100,000	$11,100,000	$89,100,000	$42,200,000
Hex Pit	$5,490,000	$4,490,000	$1,220,000	$367,000	$6,710,000	$4,860,000
Sanitary Landfills	$29,700,000	$14,000,000	$820,000	$246,000	$30,500,000	$14,200,000
Section 36 Lime Basins	$10,100,000	$5,450,000	$1,410,000	$424,000	$11,510,000	$5,870,000
Buried M-1 Pits	$13,600,000	$10,800,000	$9,090,000	$2,730,000	$22,700,000	$13,500,000
South Plants Central Processing Area	$29,800,000	$24,300,000	$13,000,000	$3,890,000	$42,800,000	$28,200,000
South Plants Ditches	$4,740,000	$3,640,000	$781,000	$234,000	$5,520,000	$3,870,000
South Plants Balance Of Areas	$46,300,000	$36,100,000	$3,480,000	$1,040,000	$49,800,000	$37,100,000
Buried Sediments	$1,860,000	$1,130,000	$30,700	$9,210	$1,890,000	$1,140,000
Sand Creek Lateral	$9,150,000	$5,380,000	$205,000	$61,500	$9,360,000	$5,440,000
Section 36 Balance Of Areas	$25,200,000	$13,400,000	$840,000	$252,000	$26,000,000	$13,700,000
Burial Trenches	$6,700,000	$5,150,000	$177,000	$53,000	$6,880,000	$5,200,000
Total	$650.000.000	$433.000.000	$363,000,000	$109,000,000	$1,012,000,000	$542,000,000

[1] All costs presented in 1995 dollars.

[2] Present-worth calculations based on a 3 percent discount rate.